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THE PRESENT VALUE AND PURCHASING POWER OF GOLD.

By H. M. Chance.

THE value of gold is fixed in the long run by the cost of production. At the present time its value—*i. e.*, its purchasing power—is abnormally above the cost of production, having increased steadily for twenty years, although within the last five years the cost of producing it has rapidly declined. The tendency, daily becoming more apparent, to accept gold mining as an industry more promising of profits than other enterprises is, therefore, in harmony with existing conditions.

The price of no product subject to the influence of competition can remain permanently lower than the cost of production, for men will refuse to produce it for such price; and, conversely, the price of such product can not be maintained at more than a fair margin over the cost of production, because many are always willing to produce and sell any product at the lower price.

We may, therefore, safely conclude that the value of metals, as of other products, is fixed by the cost of production, and that all permanent changes in value arise from increase or decrease in the cost of production. Some metals, and other products, manufactured by secret or patented processes, and some natural products known to exist over comparatively small areas which are controlled through combinations of the owners or by the sole ownership of an individual or corporation, are exempt from the influence of competition, which reaches only those products the production of which is open to all, and the output of which is limited only by the labor available for their production.

The production of few metals is artificially controlled. Aluminum

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and sodium, interesting examples, because of the abundance of the materials from which they may be extracted, have been made by patented reducing processes, and their prices thereby maintained at an artificial level.

Some of the rarer metals, of which bismuth and mercury may be taken as types, have been kept at higher prices than might obtain were production unfettered, control of the principal sources of supply having become vested in a few owners. Diamond mining may be noted as belonging to this class of industries.

Attempts to regulate the output and price of metals more largely used and more widely distributed have always failed, usually with results disastrous to the originators.

As the production of iron, lead, zinc, tin, copper, silver, and gold is unrestricted, and as their ores are widely distributed and not controlled by closely allied owners, an inquiry into their values involves merely a review of those factors affecting the cost of production as the sole and final measure of value.

The decline in the value of silver from $1.20 per ounce in 1876 to 67 cents per ounce in 1896 was possibly precipitated by legislation, but was inevitable, because the cost of producing it had declined.

As the market value of other metals suffered a like decline during the same period, the change in values is often attributed to enhanced value of gold; but, as a general decline in the cost of producing all metals was effected in the same period, and as the cost of producing gold cannot be assumed to have increased, the enhanced purchasing power of gold is merely an expression of the decline of other values.

Within this twenty-year period iron has fallen from $22.50 to $12.00 per ton, lead from 6 cents to 3¼ cents per pound, zinc from 7½ cents to 4 cents per pound, tin from 20 cents to 14 cents per pound, and copper from 23 cents to 11 cents per pound.

In 1876 2,067 pounds of iron would purchase one ounce of gold; it now takes 3,858 pounds of iron to purchase one ounce of gold, and the purchasing power of other metals has similarly declined, as shown by the following table:

POUNDS OF METAL REQUIRED TO PURCHASE ONE OUNCE OF GOLD.

	1876.	1896.	Decline in Purchasing Power.
Iron	2067	3858	46 per cent.
Lead	344	636	46 "
Zinc	275	517	47 "
Tin	103	148	30 "
Copper	90	188	52 "
Silver (ounces)	17.3	30.8	44 "

If it be found that the cost of producing these metals has declined in proportion to their fall in value, the latter must be attributed to decreased cost of production, and not to increased value of gold.

In 1876 the blast furnaces of this country were producing iron from relatively lean and high-priced ores, and a furnace making 50 or 60 tons per day was doing good work. The furnaces of 1896, producing from 100 to 300 tons per day, smelting the rich and cheaply-mined Lake Superior ores, or operated with the cheap fuel and ores of the South, with improved regenerative hot-blast stoves and other accessories of modern practice, amply account for a decline in the cost of production equal to the decline (46 per cent.) in value.

In the lead and zinc industries we find vast improvements in mining methods, rock drills replacing hand drills, dynamite substituted for black powder, and a revolution in smelting and refining methods almost, if not quite, equal to that effected in the iron industry; and we can readily believe that the costs of lead and zinc have fallen 46 or 47 per cent. in the last twenty years.

The growth of the copper mining, milling, smelting, and refining industries, in the Lake Superior, Arizona, and Montana districts; the reduced costs of mining due to the adoption of power drills and high explosives; the massive steam stamps, doing the work of more than fifty ordinary stamps; and the improvements in copper-smelting methods and in electrolytic refining,—might easily cause a drop of more than 50 per cent. in the cost of production.

Cheaper smelting of the lead ores with which silver is usually associated has lowered its cost, and modern mining methods and appliances, and radical reductions in freight charges from the mine to smelters, and the facilities afforded the smelters of bringing together at moderate transportation charges proper assortments of ores to make good fluxing mixtures, have effected a decline in the cost of production that might readily cause a drop of 44 per cent. in its market value as compared with gold.

The principal features of present practice actively operating as factors in the decline in cost of producing all of these metals are effective in all countries where these metals are produced in quantity. In this country larger benefits have probably been reaped from the application of modern methods than have been obtained elsewhere, but all mining districts, in greater or lesser degree, have felt their influence, and, wherever the mining industries are controlled by civilized owners or managers, the advantage of power drills, high explosives, improved pumping, hoisting, crushing, and milling machinery, and modern concentrating, extracting, smelting, and refining processes are appreciated and to some extent utilized.

Within this twenty-year period tin has declined in value only 30 per cent. While its cost has been lowered by modern mining methods and appliances, and by improved machinery for crushing and concentrating its ores, a large part of the tin of commerce is obtained by washing its ore (*tin-stone*) from alluvial sands and gravels, somewhat as alluvial gold is mined; and the methods in vogue show little, if any, improvement. The smelting and refining of tin from its ore (*tin-stone* or *cassiterite*) has been done by cheap and efficient methods and appliances for many years, no distinctively modern innovations effecting material reductions in cost having recently been adopted; hence it is not difficult to understand why the value of tin has fallen only 30 per cent. in the last twenty years, while these other metals have suffered an average decline of 47 per cent. in the same time.

The writer will not venture upon a discussion of the decline in market value of agricultural and manufactured products during the same period, but believes a review of the improvements in methods, appliances, and transportation would show that the decline in values can be traced to reduced cost of production.

This general decline in the cost of producing metals leads one, naturally, to inquire whether the cost of producing gold has not declined in the same way, at the same time, and from the same causes, and, if so, why its value—*i. e.*, its purchasing power—has not fallen in the same ratio, in which event relative values and market prices should have remained unchanged.

The answer is sufficiently simple. The world's store of gold has been obtained, principally, from alluvial deposits,—from the washing of the gravel-beds of streams and valleys. As this placer gold is already in the metallic state, and as the cost of transporting it to market forms a very small fractional part of its value, the reduced costs of smelting and transportation so potential in lowering the cost of other metals have not appreciably affected its cost; and, as the mining of such deposits has not materially been cheapened in the last twenty years, the cost of producing gold from placer workings has remained practically unaltered by recent inventions.

Gold won by underground mining of gold-bearing veins or lode is divisible into three distinct classes; (1) gold from "free-milling ores," in which the gold exists in a metallic state; (2) gold from "partially free-milling ores," in which some of the gold is in a metallic state and the remainder is combined with some other mineral; (3) gold from "refractory" or "smelting ores," in which the metal exists in combination with other minerals or elements.

Gold produced from all classes of ores mined underground has been cheapened by improved mining methods and appliances, a portion of

that from the second class has been further cheapened by lowered freight charges on concentrates from mill to smelter, and by improved milling, smelting, and extracting methods, while all of that extracted from ores of the third class has been cheapened by economies accruing from all of these improvements in the art.

Under the conditions governing gold mining in the past, the greater part of the production was obtained from alluvial washings,—*i. e.*, placer mining,—a considerable portion of the balance from free-milling ores, and only a small part of the output from refractory or smelting ores; but within the last five years these conditions have rapidly changed, so that now we appear to have entered upon a period in which the world's supply no longer will depend upon placer mines and free-milling ores, but will be obtained principally from deposits of refractory ores.

Improved roasting, matting, and smelting processes gave the first stimulus to this branch of gold mining; the development of cheaper and simpler chlorination processes and the cyanid processes quickly followed, and already have effected a revolution in the industry; and the end is not yet, for other processes and modifications of known processes are in sight, promising equally good or better results.

The cost of producing gold from refractory ores has doubtless fallen as much as the cost of producing iron, lead, zinc, copper, or silver; but, as gold so produced has formed but a small fractional part of the total output,—the change being recent and still in progress,—no perceptible effect upon the value of gold can yet be noted.

Any material change in the cost of producing the metals not used as money is marked at once by corresponding change in the market price, for the world's supply of metals (the stock on hand or visible supply) is but a small part of the output of a single year, and, as these metals are consumed as fast as they are produced, the market is dependent upon receiving a continuous supply of new material, and responds quickly to changes in the cost of production, often discounting them in advance.

Gold and silver are less sensitive, because the stocks on hand are so large, the inertia of the mass so great, and the influence of tradition and past experience so strong, that years may elapse before a change in the cost of production creates a corresponding effect upon their market values or purchasing powers.

The decline in the cost of producing silver had been in progress for several years—affording mine owners opportunities for enlarged profits—before its market value became seriously disturbed; but the decline, once fairly inaugurated, progressed rapidly, until quotations reached figures lower than the average cost of production.

The wide distribution of the world's store of gold, its large volume, and the fact that it is held principally by those (both corporations and individuals) having no desire to part with it, but who retain it as a convenient medium for the investment of their surplus or otherwise uninvested wealth, prevent rapid changes in its value or purchasing power. Its fluctuations are correspondingly sluggish, the addition of a relatively small stream of cheaply-mined gold causing no immediate change in the value of the great mass with which it unites. But, as the volume of this stream is steadily and rapidly increasing, the purchasing power of the whole mass ultimately must recede, until it rests at the level of the cost of production, wherever that level may be found.

The closure of the mints of the most wealthy nations to silver, with the corresponding increased use of and demand for gold, assist in maintaining gold abnormally above its value as determined by the cost of production, thus retarding the fall that otherwise might already have commenced.

Were these conditions better appreciated, the world might even now be engaged in discounting future changes, as happened upon the discovery of the Californian and Australian gold-fields when gold rapidly declined, silver rising correspondingly and being stipulated in bonds for the payment of debts.

The discovery of a California or a South Africa is, however, of less real significance than the evolution effected in working refractory gold ores, for the effects of the latter are widespread, bringing within profitable working range refractory gold deposits in all parts of the world.

Exactly how much the cost of producing gold has declined cannot be stated, but the known facts indicate a decline of at least 30 or 40 per cent. and the decline may approach, or possibly exceed, 50 per cent.; but, notwithstanding this decline, its purchasing power as compared with other metals has increased 40 or 50 per cent. That this anomaly must disappear, that the purchasing power of gold—*i. e.*, its value—ultimately must fall as much as the cost of producing it has declined, cannot seriously be doubted. It seems probable that the factors already noted may retard this decline in value, and possibly it may be marked only by slowly enhancing values for all products, and may possibly occupy a period of several years, in which event the intervening period must afford extraordinary opportunities for the profitable operation of gold mines, mills, and reducing works.

All references to fluctuations in the rates of wages as affecting the cost of production have been excluded from this discussion of values, because fluctuations in wages, while important in some mining districts as affecting individual cases, appear trivial when averaged with wage

changes in other countries, their effects being local, not general; because, if calculated on a gold basis, no general rise or fall in wages appears to have occurred in the last twenty years; because, although in several countries there has been an apparent and considerable decline in wages, this decline can safely be disregarded, as it should affect all industries in nearly the same proportion; and, finally, because the saving in the amount or quantity of labor required to produce a given quantity of any product (effected by modern improvements and labor-saving machinery and the advance in chemical and metallurgical operations) is incomparably greater than that accruing from any decline in the rate of wages.

The belief has gained wide currency that the present increase in gold production is limited to the development of newly-discovered districts,—*viz.*, the South African, Cripple Creek, and West Australian; that, when these attain their maximum, no further addition to the out put can be expected, except such as may come from the discovery of other deposits; and, as a corollary, that, barring such new discoveries, the output will thereafter decline. The considerations advanced in the foregoing pages, and the geologic and mining conditions known to obtain in nearly all mining districts, lead to very different conclusions.

In every gold-mining district, deposits exist, unavailable under the inefficient or expensive processes of the past, but which now can be worked to advantage. Placer deposits and free-milling ores are limited in extent and quantity, but the unfathomable deposits of refractory gold ores, existing in almost every mining district, may be worked upon a gigantic scale.

The enhanced purchasing power of gold should, even at the former cost of producing it, make gold mining one of the most alluring industries of the times. The furore among those alert to seize upon opportunities for profitable investments shows that increased value with decreased cost of production are recognized even while the causes producing them may not fully be understood.

The readjustment of the value of gold to its present reduced cost of production should be marked by a period of activity and prosperity in all classes of enterprise. With rising wages, and rising prices for all products, should come increased ability to discharge debts and obligations of all kinds; and with enhanced values should come such renewed confidence in the future as will prompt men to undertake those vast constructive enterprises which furnish employment and lighten the burdens of mankind. The writer believes we are entering upon a period of unexampled prosperity, which shall have, as its most potent factor, an enormous addition to the world's store of gold.

QUACKERY IN ENGINEERING EDUCATION.*

By Edgar Kidwell.

THE articles on "Education of Mechanical Engineers" in the December issue of this magazine are of more than ordinary interest to the educational world. In the paper by Mr. Emery we find sound advice and pertinent suggestions which at once stamp their author as a man of profound observation and extensive practical experience in engineering and investigation. In marked contrast to this is the paper of Mr. Thurston, which presents no new ideas on education, but rather a reflex of opinions unhappily too prevalent in our engineering schools. He again echoes the old cry that the profession which he is following "is coming to be one of the most truly learned, if not actually *the* most learned, of all the professions," and presents the usual array of magnified statements as to what is accomplished in technical schools. Such assertions are greatly to be deprecated, since in the end they mislead the uninitiated and produce only harm. The tendency to put forth such questionable statements is unfortunately on the increase, which fact furnishes ample proof of the existence of the evil that forms the subject of this article.

By quackery is here meant any promise or pretence to do that which cannot be done, either because the thing is in itself impossible, or because he who made the promise knew that the means to execute it were wanting.

The trustees of a technical school are usually selected, not because they are experts in education, or have more than a passing interest in it, but on account of their high position in life, or because they have a solid bank account. Since the position is one that adds to their prominence, men eager to shine before the public frequently accept it without any intention of burdening themselves with the cares certain to come if the duties of their office are efficiently discharged. These men are not able to formulate accurately the qualifications necessary in a professor, and hence their selections are often unwise. They are frequently influenced in their choice by religion or politics, and especially by the kind of reputation which a candidate for a chair has obtained by mere declamation in public and

* We invite a perfectly free and frank discussion of the subject here broached,—alike from those engaged in educational work, from college graduates, and from practical men. The space necessary for the statement of all essential facts will be gladly accorded, but participants in the discussion will readily appreciate the necessity for brevity.—THE EDITOR.

keeping his name in print. A searching investigation into the candidate's real fitness for his duties is very rarely made.

Erroneous statements of what the school can do are a most fruitful source of educational deception, and are due very largely to the appointment of the kind of men just mentioned. They have done more to injure technical education in the estimation of the public than any other single cause. Students spend four years at college; follow a course often poorly laid out and inefficiently taught; get an idea that they are exhausting the subjects they are studying; imagine that a smattering of work-shop or laboratory practice has made them into engineers; and on graduation day go forth with the conviction that they are about to conquer the engineering world. This is unjust to the student, since it makes him inclined to dictate to his superiors; it is more unjust to the employer, who is obliged to convince the young men of their error. Managers of engineering concerns have no time to waste on such work, and very properly claim that it is no part of their duty. Their feeling in this matter is fully expressed in the following statement, made by an eminent engineer employing thousands of men, many of whom are technical graduates: "By far the most important thing these schools need to do just now is to disabuse their young men of the idea that on commencement day they are prepared to occupy the office of manager and run the whole place; next to that, let the schools be honest, and, when they give the student a lot of mere theory, then tell them it is mere theory, and not delude them with the idea that it is practical engineering." The evil thus deplored will continue as long as we find heads of technical schools ready to make, *ex cathedra*, such statements as the following: "Even in the instruction in manual training . . . . the student, under the tuition of an expert, and following the systematic course laid out for him, becomes singularly expert in a wonderfully short time. The equivalent of a few days' work makes him a good smith, and he welds iron with facility and certainty; the equivalent of a few weeks' work at the anvil makes him a good worker in steel, and he makes and tempers his own tools with entire success. In the foundry he quickly learns the principles of his art, and it becomes difficult to find a pattern that he cannot handle. In woodworking and machine-shop practice he quickly learns to handle tools with the ease and skill of an 'old hand.' All this is done, not to make him a good mechanic in the usual sense, or to teach him a trade, but to enable him to design intelligently, to criticise good and bad work, to indicate the best methods of doing the work directed by him, and to guide the workman intelligently."* If these statements mean the

* From Mr. Thurston's article in the December issue of this magazine.

same to Mr. Thurston that they do to engineers and mechanics, then they furnish a sample of exaggeration and bad logic. They are not true, and never can be. The most brilliant student who ever graced a school cannot become a good smith in a few days or a few months. A few days will not suffice to teach him to "strike" like a professional, or develop his muscles sufficiently to do so. If one of these men should try to bore out an eight-foot cylinder, he would soon drop the idea that he can handle tools "like an old hand." Since he who is himself ignorant of how to do a thing cannot guide another who does know how to do it, it is a travesty on logic to talk of such a man "indicating the best methods of doing work, and guiding the workman intelligently."

The writer is heartily in favor of work-shop practice in schools, and has under his charge a shop which, in point of equipment and competent instructors, is fully the equal of the one alleged to have produced the results mentioned by Mr. Thurston. Extended experience with this and other shops has shown the writer that from the very nature of things such results cannot be obtained here, or in any other school, whether these institutions admit this fact or not. A student is by no means a good smith, or expert engineer, because he can weld up a broken valve stem, or adjust a valve gear; there is no glory in teaching such simple matters; it is our duty to teach them, and, if we do not, then for what is our school really fit?

The only legitimate object of a technical course is to give instruction in the principles underlying all engineering, and to familiarize the student with such practical applications of these principles as can be learned at school more quickly than elsewhere. Within the limits of equipment which any school can find the time and means to operate, it will be impossible to handle any large practical problem or constructive work. What is taught can be well taught, and there is absolutely no necessity for the amateurish and unmechanical work done in many school-shops. But, no matter how well the work is executed, it is necessarily small in size and limited in its range of subjects; hence such work cannot produce good smiths, or any other kind of mechanics; to claim otherwise is educational quackery, and the writer appeals to every experienced engineer to say whether this statement is not literally true.

Another form of quackery is found in the specious wording of catalogue matter. The catalogue is the school's letter of introduction to the public. Through it the majority of the people have to draw their conclusions respecting the intentions and equipment of the institution. It is, therefore, clear that any catalogue statement which, by specious wording, leads one to infer that the

school possesses certain material when it does not, or that it is prepared to teach properly certain branches, when it really is not, is evidence of quackery. Yet few catalogues are specific enough to give an accurate idea as to just what work the institution is really prepared to do. All through we find such stereotyped phrases as "a large equipment," "electrical laboratory and lecture-room, with all requisite appliances," "well-appointed library," "laboratory with all the instruments needed for a complete and thorough course in physics," etc. Such phrases tell nothing, and the writer has invariably found their use indicative of poverty. There is not in this country to-day a laboratory equipped with "all the instruments needed for a complete and thorough course" in anything, since new discoveries occur faster than we can provide apparatus to illustrate them, even if we have unlimited money.

A certain school undertook the herculean task of training men for mechanical engineering, without providing any shops or mechanical laboratories. To gloze over this fatal deficiency in equipment, it states in its catalogue that "the student enters the shop* with hands and mind free to examine all processes, operations, and machinery (?), and is ready at the call of the teacher to witness any operation of special interest. Provided with note-book, pencil, calipers, and measuring rule, the student sketches the most important parts of the various machine-tools, notes down the successive steps of each of the important shop processes, as illustrated by the pieces operated upon, and follows the pieces of work through the shops, from the pig or merchant form to the finished machine." In other words, at this institution engineering is to be learned by "looking on." What would be thought of a school which pretended that chemistry can be learned by watching a teacher manipulate apparatus? In both these cases the knowledge acquired is merely superficial, and to claim otherwise is an attempt to mislead the public.

The spirit of rivalry between institutions tends to foster quackery. It does not logically follow that, because one institution, to meet a legitimate demand, has established a certain course and made it a success, all other schools should establish a similar course; yet the spirit of rivalry between schools is causing this very thing to be done repeatedly. A director who wants to boom himself advocates this policy, and it is usually very alluring to a board which does not see the "true inwardness" of the matter. Departments for which there is no real demand are established, buildings are erected, professors are appointed, a great noise is made before the public, and a new specimen of educational quackery is inaugurated. The equipment and assistants neces-

* An outside shop which the student is visiting.

sary to make these new departments a success are not provided, and only a beggarly sum is allowed for current expenses. The work done is of a most inferior grade, and does not properly prepare the student for his future.

Often, again, instead of genuine equipment, we find that "the larger and better schools usually operate, as a piece of scientific apparatus, an 'experimental steam-engine,' representing $10,000 to $15,000, and working up to perhaps 200 h. p. in some cases, and costing large sums daily for its operation."* This kind of thing makes a great show. It gulls the capitalist who has some money to donate, and it deeply impresses the papas and mammas of prospective students, and—that is about all of it. There are several of these engines in use, and certain institutions are trying to obtain money to purchase more of them. Yet what results has any one of these machines produced? Has a single fact of any value to, say, the Edw. P. Allis Co., or any other builders, ever been learned from them? If not, then for what are they really good, except to give the student practice in starting, stopping, and testing, all of which can be done just as well on an engine costing not over $700? The writer considers them mere show-goods, purchased through mistaken judgment, or purely for advertising purposes. If the money these machines cost had been judiciously expended on apparatus and books selected for the real benefit of the student, it would have been more wisely invested, and would also prove that Mr. Thurston's statement that $1,000,000 is needed to "make a beginning" for a technical school is an assertion having no basis in fact. If money is wisely expended, and the officials attend strictly to their legitimate business, instead of trying to run a department and at the same time conduct a lot of tests for money, or turn out a multitude of books with paste-pot and scissors, or supervise half-a-hundred draftsmen getting out plans for a town-sewerage system, then some educational results superior to the usual grade can be got, and for much less than $1,000,000 "as a beginning."

Again, the financial embarrassment caused by the show-policy produces evil results in the retention of incompetent students. When an institution charging tuition fees is pressed for money, and there are fifty to one hundred mediocre men in its classes, it rarely drops out any but the very worst. An incompetent hangs on for years, his length of stay and his good intentions are finally considered the equivalent of some good work, and he gets a "sheepskin." He is a failure later, and has wasted valuable years of his life,—years which might have produced golden results, had his professors been conscientious enough to turn him out of their classes, and advise him to take up some work

* Thurston, *loco cit.*

for which nature had intended him. The writer is firmly convinced that the worst evil in the so-called education of to-day is the almost universal practice of schools trying in every way to increase their attendance, without any regard whatever as to whether their students properly belong in such a school. Boys whose parents have to slave for years to educate them and are wholly incompetent to decide what their sons should be taught are unhesitatingly admitted into classical and literary courses, and toil for years on the ancient languages, general literature, and philosophy, and are fully prepared for the holiday of life. New thoughts, longings, and ideals are bred into them; yet their training is like the cup of Tantalus,—it gives them absolutely no means of satisfying the desires it has created. When they graduate, they are incompetent to earn their living; they have no money, influence, or connections to help them to that station in life for which they have been fitted at school; they are forced to accept positions the very environment of which makes their knowledge a source of misery to them. Is it not wrong, in fact, criminal, to wreck one's happiness in this way, merely that the college register may be lengthened a little? The writer thinks so, and that it were far better to teach such young men a trade, or send them to a business college, or do anything else with them, provided they are taught to earn their bread, and be self-sustaining.

One of the very worst forms of educational quackery is due to the prevalent custom of allowing professors to conduct an engineering practice outside of their school duties. The inevitable result is a rapid diminution of the professor's usefulness and honesty, since such work is liable to wholly engross his time, and is destructive to the morals of his students. In the early part of their college course, if not all through it, students are prone to idealize a professor somewhat; and, when they see him cheating them of the time and instruction which are their just due, what is more natural than that they should conclude that engineering is a cheating business all through? When men of experience in such matters read in the journals the advertising cards of consulting engineers, chemists, metallurgists, etc., inserted by technical professors, they can draw but one conclusion,—that every man who does this thing will, for mere money, do over and over again work that adds nothing to his mental acquirements, and thereby waste his own time and that of his students. No man can do this, and at the same time attend faithfully to the various duties which are inseparably connected with the proper supervision of an engineering course; therefore, an institution which permits it is guilty of educational quackery. This becomes of even a ranker kind when the professor, instead of laying out the course of training best for the student, uses him as a

mere assistant in private work, narrows his opportunities of learning, and puts the proceeds of the student's labor into his own pocket.

Lest there be some who think that the above statements are not based on actual fact, the writer will mention a few cases that have come under his observation. Those who care to investigate can find many more just as bad.

Some years ago a leading school appointed a professor in one of its chief departments. This professor then got a further appointment on the faculty of another college, and also took upon himself a third duty by accepting a civil office. Lest he should be burdened by a surplus of time, he opened a commercial and semi-professional establishment, took in all kinds of work, and kept busy a number of private assistants. His appearance in the class-room was narrowed down to a few hours per week; what he said when he did appear amounted to nothing; and, when an extra pressure of outside work occurred, he cancelled even those few hours. Would it be much short of a miracle if that man's teaching was of any value? When his students left school, and, too late, woke up to the fact that they had learned nothing, did they not have just cause to consider themselves swindled by their *Alma Mater?* Yet this man's name still stands in the school catalogue as a bait for students, while he continues to fish for dollars at the expense of his teaching.

So long as the foremost men in prominent schools dabble in just this sort of work, is it to be wondered at that the professors under them go in heartily for it, and that much of the equipment of such a school looks like an aggregation of ancient relics. As long as the students do not rebel, and parents are perfectly satisfied, it is not probable that any change for the better will be made.

The case which perhaps appeals most strongly to the writer is the following. A certain prominent university had at the head of one of its engineering courses an able man,—one who has earned his fame as a successful engineer. He accepted the position of chief engineer of a large corporation, started to design and erect a plant costing several millions of dollars, and had to hasten the work to finish in time. Though the authorities of that school were fully cognizant of the facts, this man continued to hold his professorship, and day after day he appeared in the class room totally unprepared. He explained nothing, read occasionally a "lecture" out of an ancient note-book, and then whiled away the remainder of the time in giving excellent moral advice which he himself never followed. Was it any wonder that, when the year was over, not a student in that class could compute the thickness of a board for the top of a bench, and feel enough confidence in the result to sit on the bench when finished? One of those students

early found out his deficiencies; they were later made up by hard study during hours which should have been devoted to sleep; but that student determined then and there that, should he ever have anything to do with education, he would strain every nerve to keep quackery out of it, and he has kept to his resolution.

Strict accuracy is essential in all engineering teaching and publication. Yet the longing to keep before the public which is so prominent in some men leads them to issue engineering literature which is extremely inaccurate, and perhaps responsible for serious mistakes. Surely such statements as the following cannot do otherwise than mislead the engineering tyro:

> Hemlock Spruce Fir (*Abies Canadensis*) is found in the same range of climate as the black spruce, but it prefers a more hilly country. It forms extensive forests in Lower Canada. It attains a height of 70 feet (20.73 meters), and occasionally even 100 (30.5 meters), and reaches a diameter of 2 feet (0.61 meter). The leaves are dark and stiff, four-sided and needle-shaped. The cones are ¾ or 1 inch (1.9 to 2.5 centimeters) long. The wood resembles that of the white spruce, and is generally more highly valued. Its strength, durability, lightness, and elasticity form a combination of good qualities that makes it, for some purposes, the best wood in our markets.

The *habitat*, metric measures of the cones, and configuration of the leaves may be very important to somebody, but what an engineer wants to know is that hemlock is a rather hard, extremely brash, and treacherous wood, liable to crack open in the rings, and is usually so wind-shaken that the interior is a mass of splinters; hence this wood is used in only the most inferior class of structures, and in some localities it is not considered worth cutting for the market, even for firewood. So long as this grade of engineering authorship can gain a man a "reputation" with the public, we cannot hope to see the proper kind of education given in our technical schools.

THE VAST IMPORTANCE OF THE COKE INDUSTRY.

By John Fulton.

THE trend of general investigation in manufacturing industries is usually toward ultimate results; only limited attention is afforded to the relative importance of the elements which contribute to these products. The genesis and sources of the elementary materials for manufactures, whose combination contributes so largely to man's comfort, civilization, and power, are overlooked entirely, or relegated to inconsiderate positions.

The fact is that these exist in such abundance that we are led to overlook their real importance, our familiarity shading the values of these essential elements that render possible the marvelous growth of our manufactures.

If some great revulsion were suddenly to arrest all movements of our railroad systems, and travel and freight were compelled to seek the old-time stage-coaches and the Conestoga wagons, what a shock would be given to the body politic! The great value of the railroad service would be realized to an extent not hitherto appreciated. The same is true of fuel supplies in all metallurgical operations. If iron and steel manufacturers were compelled to go back to the exclusive use of charcoal fuel, an immediate and large reduction in output would follow, with most alarming consequences; rapid depletion of the forests would ensue, ending in their exhaustion.

Even by the use of the more compact mineral fuel, anthracite coal, with its slow combustion in smelting operations and increased costliness, the present output of metals could not be maintained. And, like the charcoal fuel, the supply from the five hundred square miles of anthracite coal area would suffer similar decrease and exhaustion at a time not far distant.

With coke the case is entirely different, as coke enjoys permanent sustentation from the coal in the two hundred and fifty thousand square miles of coal fields in the United States. The supply of this most excellent metallurgical fuel may, therefore, be regarded as *practically inexhaustible.*

As the coal for the manufacture of coke is distributed widely over the United States, a uniform moderate cost is assured.

The order in which these fuels have secured supremacy in metallurgy is shown in the table on the following page.

Years.	Charcoal.	Anthracite Coal.	Coke.	Remarks.
1854.	342,298	339,435	54,485	All net tons.
1855.	339,922	381,886	62,390	Anthracite leads charcoal.
1869.	392,150	971,150	553,341	Coke leads charcoal.
1875.	410,990	908,846	947,545	Coke leads anthracite coal.
1890.	703,522	2,448,781	7,154,725	Era of coke.

From this table* it appears that it required time to assure furnace managers of the relative values of these fuels, considering cost, calorific energy, and quality of pig-iron. However, during the thirty-six years of testing, the large advance in the use of coke is remarkable. Evidently it is destined to maintain its present supremacy as the metallurgical fuel.

The early efforts in the manufacture of coke followed, in a modified manner, the methods used in making charcoal.

The coal was piled in heaps, or mounds, somewhat similar to the *meiler* mounds of charcoal, with the usual flues for firing and burning, and billets of wood for starting the carbonizing process. During the progress of coking, the burning is arrested by banking the mound with fine coke-dust. It is needless to add that this method was wasteful of the coal, producing a coke of inferior quality, chiefly owing to the irregularity inherent in this plan of manufacture.

This primitive period of coke-making was followed at successive intervals by the three typical coke-ovens now in general use,—the beehive, the vertical retort, and the shaft or Appolt ovens. The position of the coal in coking in these ovens has been illustrated by the use of a common red brick. Laid on its broad side, it represents the coal in the beehive oven; on its narrow side, the vertical family of coke-ovens; standing on its end, the shaft or Appolt type of oven.

The beehive oven.—Some advocates of the modern types of coke-ovens have wasted considerable effort in undervaluing this "ancient oven"; but, like the Israelities under the persecutions of Rameses in Egypt, they have increased and multiplied, until at present, with the exception of less than two hundred, they constitute the whole of the forty-five thousand ovens in the United States.

The beehive oven evidently took its form from the old time beehive, and its operation from the old round oven for baking bread. The following plans and sections will show the ancient and modern conditions of this oven.

The initial or old-type beehive oven was diminutive in size and inefficient in action. The modern oven is circular, with a diameter at base of twelve feet, and a height (of the interior of its dome) of seven feet above the floor. An oven of this size, with good coking coal, will

* Mr James M. Swank—"Iron in All Ages."

COAL HOISTING PLANE AND BEEHIVE OVEN PLANT. H. C. FRICK CO., YOUNGSTOWN, CONNELLSVILLE REGION.

DRAWING COKE FROM OVENS.

produce four tons of excellent marketable coke in forty-eight hours.

During the past decade the operations of coking in the beehive oven have been much improved, securing an increased percentage of coke, with more thorough and complete carbonization. Carefully-conducted tests at the coke works of the Cambria Iron Company, in the Connellsville region, Pennsylvania, give the following results:

No. of tests. Averages.	Coal charged. Lbs.	Time in oven. Hs. Ms.	Market coke made. Lbs.	Fine coke or Breeze. Lbs.	Ashes. Lbs.	Per cent. of yield.				Per cent. lost.	Remarks.
						Market coke.	Breeze. Small coke.	Total coke.	Ash.		
4.	10 385½	43.28	6987¼	77	244	67.28	0.74	68.02	2.35	29.63	Watered in oven.
2.	9.910	44.00	6591	119	229	66.50	1.20	67.70	2.31	29.99	Watered when drawn.
2.	11.965	70.00	7850	137½	244	65.61	1.15	66.75	2.05	31.19	Watered in oven.

The proximate analysis of Connellsville coal is as follows:

Moisture 212° F.....	1.25 per cent.	Volatile matter.....	31.80 per cent.
Fixed carbon.....	59.79 "	Ash	7.16 "
Sulphur.....	0.53 "	Phosphorus	0.024 "

The *theoretic coke* from this coal is 67.27 per cent., made from the following elements:

Fixed carbon.....	59.79 per cent.
Ash.....	7.16 " "
Sulphur	.32 " "
Total.....	67.27 " "

The average of the 48 hours coke, watered in oven, is 67.39

per cent. About 8 per cent. of carbon is consumed in the oven, but this loss is fully compensated by deposited carbon from the tar gas evolved in coking. This deposited carbon gives the bright silvery glaze that distinguishes the Connellsville and other beehive-oven cokes.

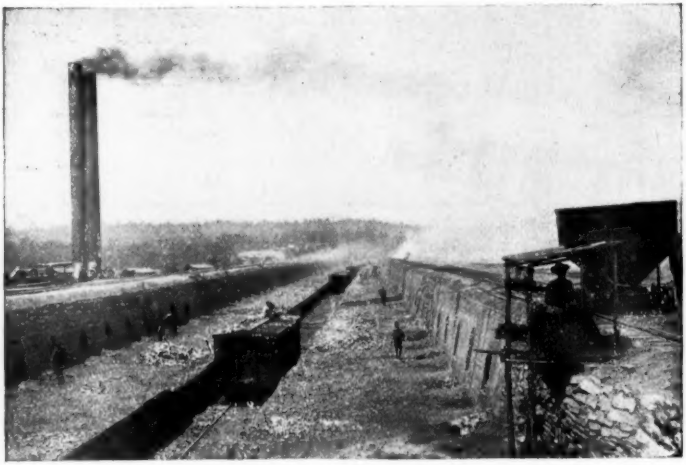
The vertical retort ovens.—This modern family of coke ovens had its genesis in the difficulty of coking the inferior dry coals of continental Europe in the beehive oven. The Knab oven of 1856 is usually regarded as the initial or root type, from which all the succeeding retort coke-ovens have been evolved. They consist of a series of vertical chambers 30 feet long, 16 inches wide, and 5½ feet high.

The coking-chamber has side and bottom flues, from which the heat for the carbonization of the coal is transmitted. This heat is derived from the combustion of the gas evolved in coking, deprived of its tar and ammonia, and returned to these flues for the necessary heat-supply.

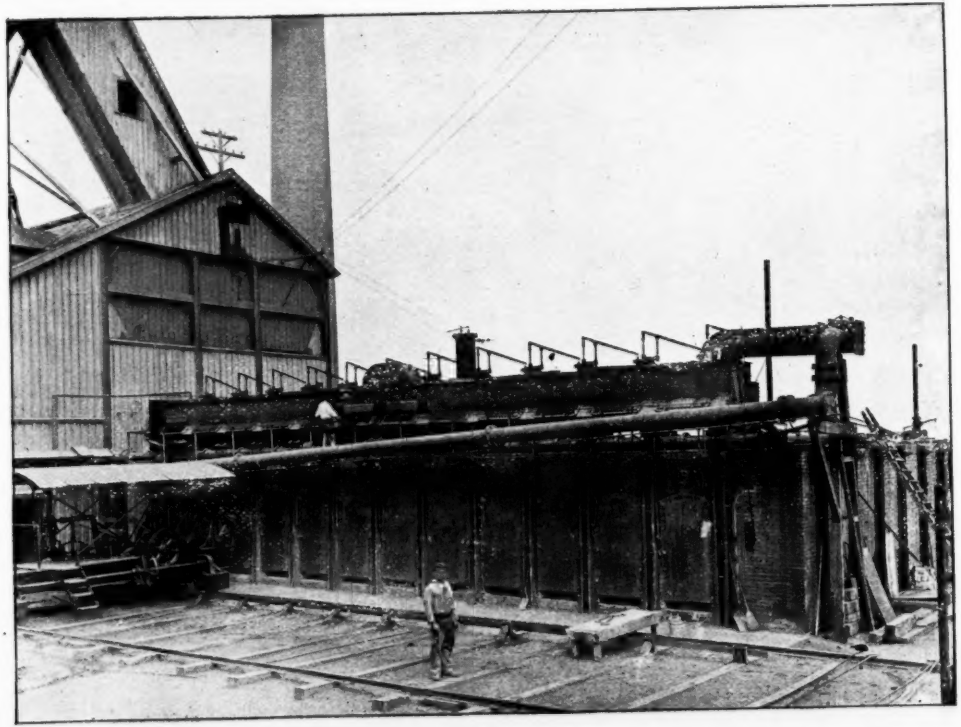
Theoretically no combustion of carbon takes place inside the oven, as no air is admitted into the coking-chamber. The following plan and sections will convey a general idea of the structure of these ovens.

These coke ovens accomplish, by their construction and operation, a three-fold service.

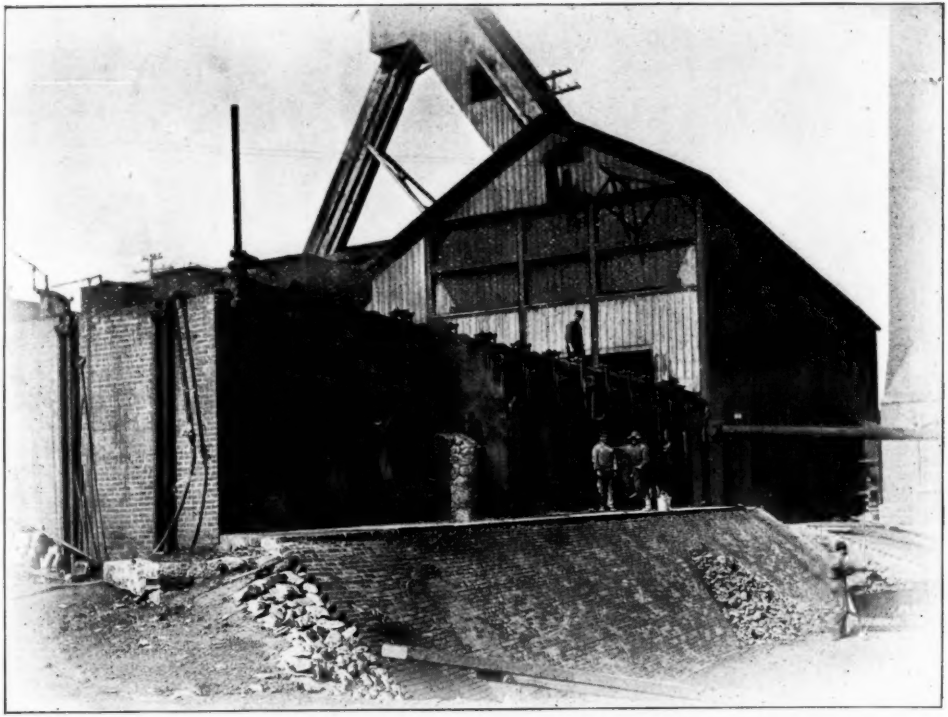
(1) By their continuous heat, they utilize the small volume of fusing matter in the "dry" coals. (2) They produce a larger per-



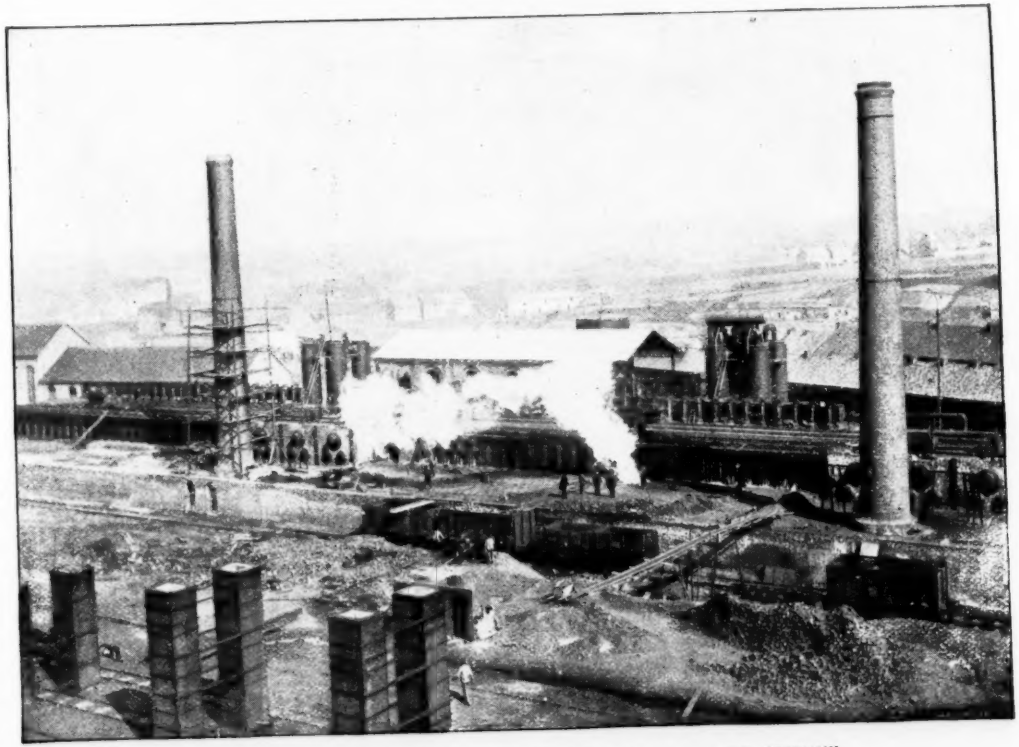
COKE OVENS. PRATT MINE, ALABAMA.



SEMET-SOLVAY RETORT COKE OVENS AT SYRACUSE, N. Y. VIEW FROM FRONT, SHOWING PUSHER.



SEMET-SOLVAY RETORT COKE OVENS AT SYRACUSE, N. Y. VIEW FROM BACK.—DISCHARGING.

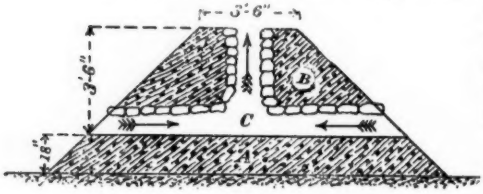


48 SEMET-SOLVAY RETORT COKE OVENS AT PHŒNIX WORKS, RUHRORT, GERMANY.

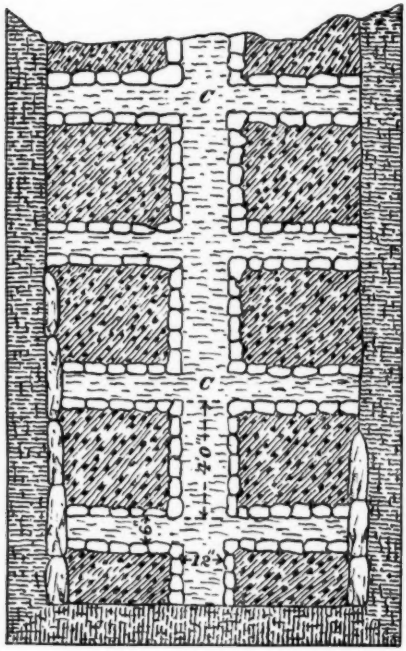
centage of coke than the beehive. (3) They economize the labor of drawing out the coke, by the use of a mechanical "pusher."

Supplementary to these economies, the by-products of tar and ammonia sulphate are saved, by exhausting and condensing the gaseous products evolved in coking.

The following are the chief competitors for public recognition at this time: Simon-Carvés, Semet-Solvay, Hüssener, G. Seibel, Otto Hoffman, and Festner-Hoffman.



Cross Section.

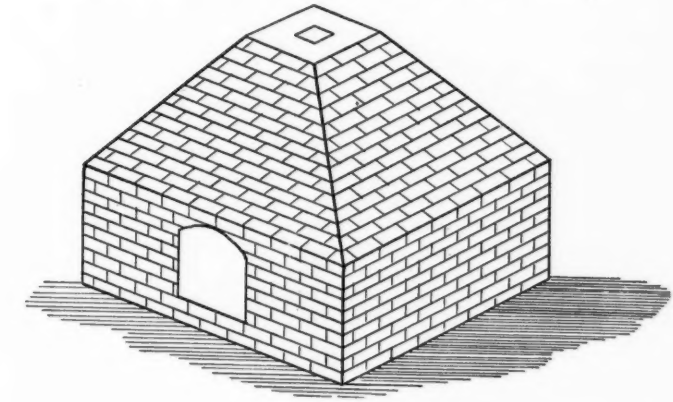


Ground Plan.

BENNINGTON COKE PITS.

A bank of twelve Semet-Solvay retort coke-ovens has been in operation for the past three years at the large chemical works of the Solvay Process Company, Syracuse, New York. A thorough test was made at these ovens in May last, at the request of Mr. A. G. Moxham, president of the Johnson Company, of Lorain, Ohio. This test, with 2,058½ tons of Connellsville coal, developed the work of this oven accurately. It made, in two careful tests, an average of 71.035 per cent. of coke from this coal. The theoretic coke from it is only 67.88 per cent., exhibiting a large gain in deposited carbon. With well-sustained heat, good furnace coke can be made in twenty hours. Each oven will produce

PLAN OF COKE OVENS NEAR NEWCASTLE-UPON-TYNE.



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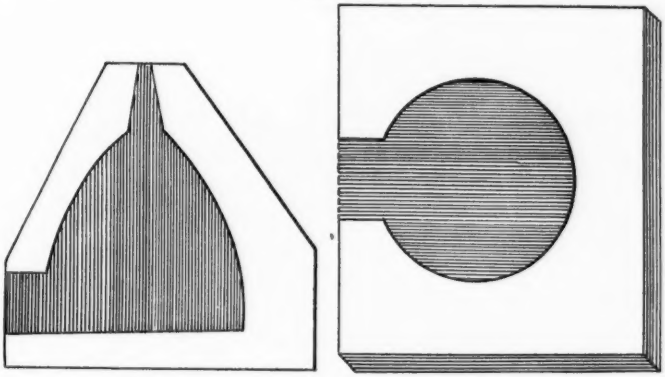


SECTION. GROUND PLAN.

an average of four tons of coke per day. A plant of fifty Semet-Solvay retort coke-ovens is now being constructed at the Dunbar Furnace, in the Connellsville coke region, Pennsylvania.

The Hüssener coke oven is very similar to the Semet-Solvay, but has thicker lining in its heating flues. Some recent efforts have been made to reduce the thickness of the interior lining of these flues. This oven is a very substantial retort.

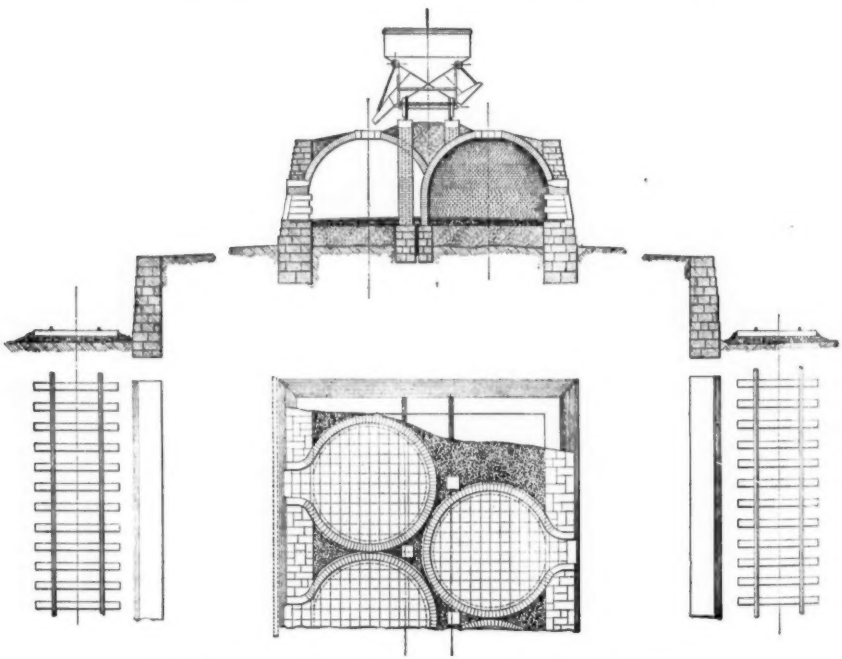
The G. Seibel ovens have also much in common with Semet-Solvay

ovens. The plan and section following exhibit a plant of forty-eight of them.

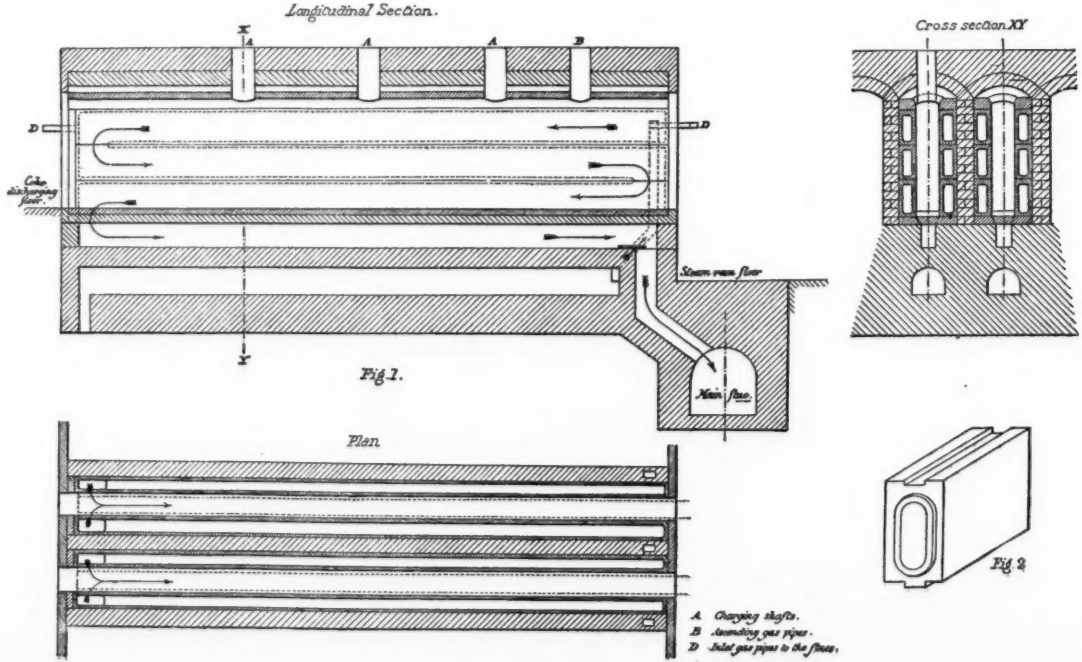
The Otto-Hoffman oven has chambers 33 feet long, 16 to 24 inches wide, and 5 feet 3 inches high. It has vertical side flues. The accompanying drawings show full details.

This oven has very complete condensation and ammonia factory plants attached. A plant of sixty of these ovens, producing coke for the Cambria Iron Company, at Johnstown, Pa., cost, with appliances for saving by-products, $301,500.23, or $5,025 per oven. It is reported that it is designed to add sixty ovens to this plant, making in all one hundred and twenty. The cost of the sixty additional ovens is estimated at $166,000, showing the cost of each oven, without apparatus, to be $2,766.66. This plant, when thus reinforced, will have cost, including the by-products-saving appliances, $3,895.83 per oven.

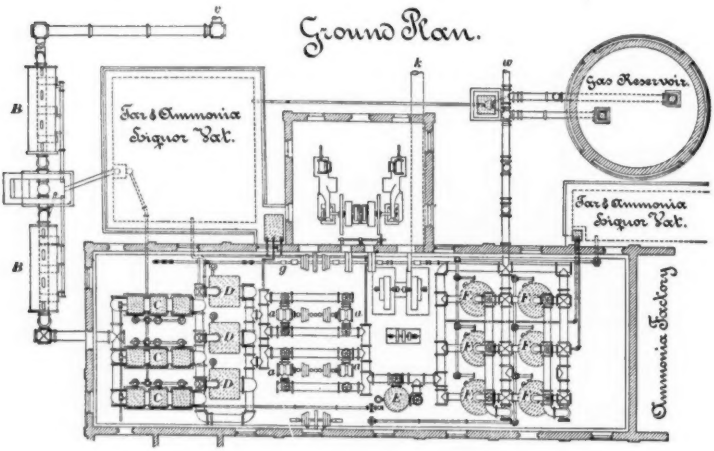
The Festner-Hoffman Oven.—The general design in planning this



PLAN AND SECTION OF BEEHIVE OVENS, BY WILKINS & DAVISON, PITTSBURG, PA.



SEMET-SOLVAY COKE OVEN.



CONDENSATION PLANT AT THE JULIENHUTTE.

oven is to economize in its construction and operation. The following drawings illustrate its general design.

It will readily appear that the recuperative compartments of this oven are less expensive than the double regenerators of its prototype, the Otto-Hoffman oven. It will also be noticed that its heating flues have been given the horizontal posture, which is undoubtedly an improvement. It has also the further advantage of direct or continuous heat appliance. Dr. Slocum, of the Gas Engineering Company, of Pittsburg, Pa., has designed an oven after the Hüssener type, but with the thickness of the flue lining very materially reduced,—a step in the right direction.

It will be noticed that the differences in the structure of the retort class of ovens consist more in details than in organic principles. Modern practice is sustaining the horizontal-flue system, with reduction in thickness of flue lining, through which the heat is transmitted to the coking chamber. This thinning of the flue lining secures economy in the rather costly regenerator and recuperator attachments to some of these ovens.

The following table exhibits the approximate relative value of these ovens in the manufacture of coke and saving of by-products.

The initial work thus far, in the introduction of the retort coke-ovens in the United States, has afforded very few reliable data as to the actual cost of ovens and their by-product-saving appliances. This is evident from the fact that the cost of such plants in Germany,

TABLE EXHIBITING THE RELATIVE ULTIMATE ECONOMY OF PLANTS OF THE THREE TYPICAL COKE-OVENS,—SINKING COST IN 20 YEARS.

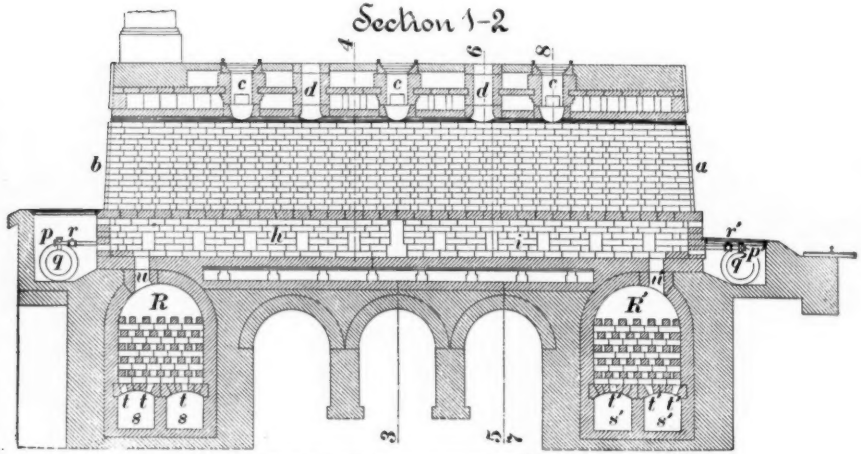
Name of Oven.	Cost per oven.	Cost of condensing plant per oven.	Total cost per oven.	Time in coking.	Daily output per oven, net tons.	Number of ovens to make 118,800 net tons per year.	Total cost of plant.	Maintenance and repairs 5 per cent. per year on investment.	Maintenance and repairs per ton coke.	Sinking plant in 20 years, per ton coke.	Labor making coke and saving by-products.	Total cost per ton.	Per cent. of coke made.	Value of units of coke over 63 per cent.	Value of by products per net ton coke.	Ultimate cost for net ton coke.	Remarks.
	$	$	$	H. M.			$	$	$	$	$	$				$	
Beehive	300	—	300	48.00	2.0	162	48,600	2430	0.02½	0.02½	0.35	0.40	65	—	—	0.40	Not saving by-products.
Thomas	800	—	800	48.00	3.9	84	67,200	3360	0.02¾	0.02¾	0.32	0.37½	65	—	—	0.37½	" "
Belgian	1000	—	1000	48.00	2.7	120	120,000	6000	0.05	0.05	0.30	0.40	69	0.07	—	0.33	" "
Coppée	1000	—	1000	48.00	2.3	141	141,000	7050	0.06	0.06	0.30	0.42	70	0.08¾	—	0.33¾	" "
Bernard	1200	—	1200	48.00	2.5	130	156,000	7800	0.06½	0.06½	0.30	0.43	70	0.08¾	—	0.34¼	" "
Simon-Carvès	1300	1000	2300	48.00	2.3	141	324,300	16,215	0.13½	0.13½	0.45	0.72	71	0.10½	0.32	0.29½	Saving by products.
Semet-Solvay	2000	1000	3000	22.00	3.7	88	264,000	13,200	0.11	0.11	0.45	0.67	71	0.10½	0.32	0.24½	" "
Hüssener	2000	1000	3000	48.00	3.3	98	294,000	14,700	0.12	0.12	0.45	0.69	71	0.10½	0.32	0.26½	" "
G. Seibel	1700	1100	2800	48.00	3.0	108	302,400	15,120	0.12¾	0.12¾	0.45	0.70½	71	0.10½	0.32	0.28	" "
Otto-Hoffman	2300	1300	3600	36.00	3.3	98	352,800	17,640	0.14⅞	0.14⅞	0.45	0.74⅜	71	0 10½	0.32	0.31¼	" "
Festner-Hoffman	2100	1100	3200	36.00	3.2	101	323,200	16,160	0.13⅝	0.13⅝	0.45	0.72½	71	0.10½	0.32	0.29¼	" "

NOTE: It is assumed, in the above table, that the Connellsville coal is the base of facts as estimates in all the products.

France, and England affords no safe guide to their cost in the United States, as these introductory plants require the importation of much of the materials for their construction besides involving abnormal expense in the difficult and intricate work in their erection.

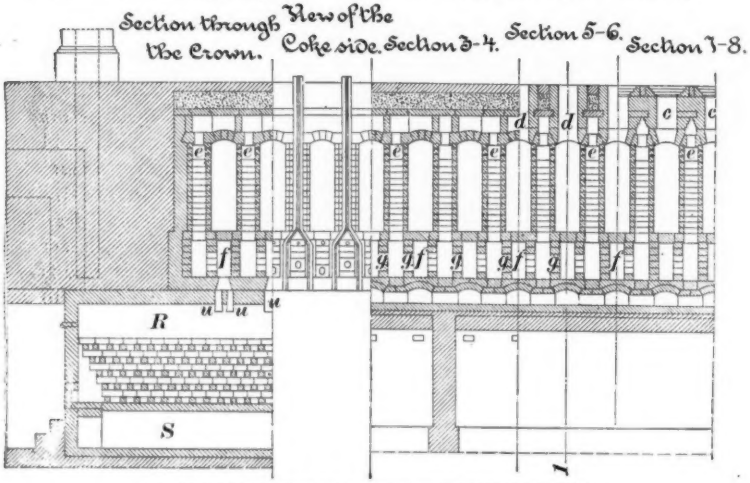
Two chief difficulties confront the introduction of these ovens: (1) the large cost of the plant; (2) the necessity of continuous work. But, as the coking of the "dry" or secondary coals becomes a necessity, these retort coke-ovens will come into general use. Recent investigation has disclosed the fact that their value is not confined to the coking of the "dry" coals exclusively.

It has been found that some of the beehive coke made from the



LONGITUDINAL SECTION OF AN OTTO-HOFFMAN COKE OVEN.

coals very rich in bituminous matter splits up into finger-pieces when charged into blast furnaces,—a fact which causes some hesitation about using it. The explanation of this undesirable result is, in most instances, evidently in the fact that all the coals very rich in bituminous matter swell greatly in the freedom afforded in a beehive oven;

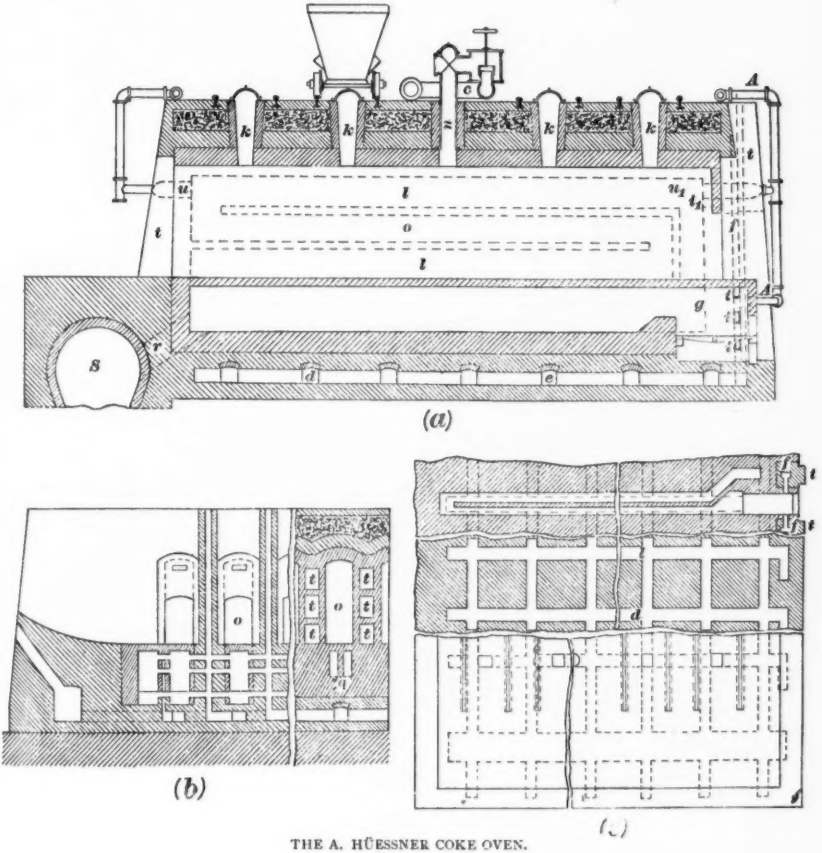


TRANSVERSE SECTION OF AN OTTO HOFFMAN COKE OVEN.

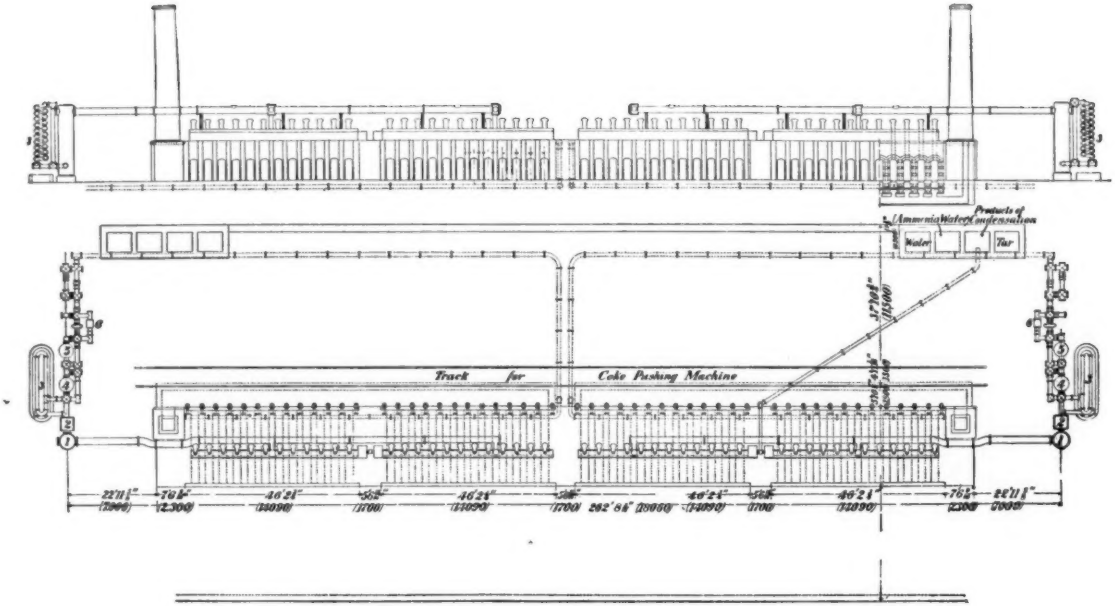
this expansion is followed, at the closing period of coking, by a corresponding amount of contraction, slicing the coke with multiple narrow planes at right angles to the floor of the oven.

It has also been shown, in part, that the confined space in the narrow chamber of the retort oven restrains abnormal expansion and contraction; hence the coke suffers less than from the multiple plane structure of the beehive.

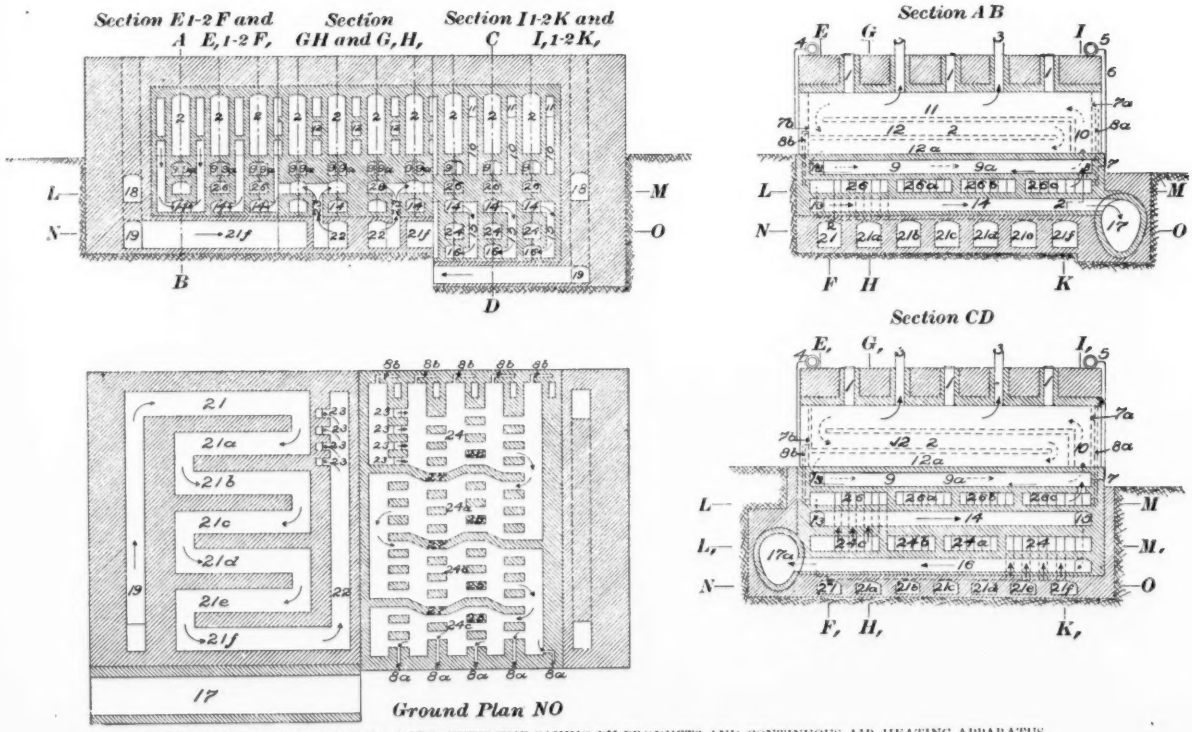
It is, therefore, becoming evident that the retort ovens have their most useful office in coking the extremes of coals,—those poor and rich in bituminous matter.



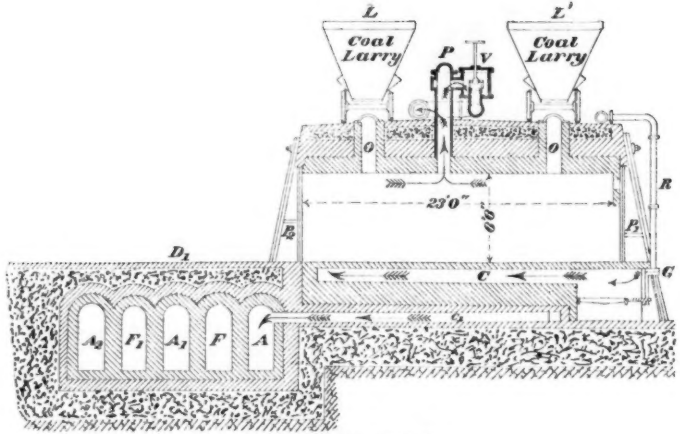
THE A. HÜESSNER COKE OVEN.



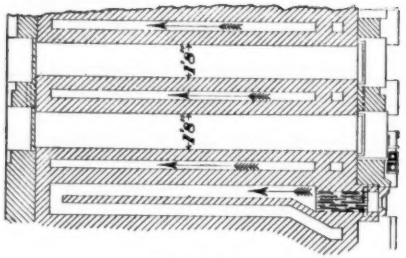
PLAN AND SECTION SHOWING PLANT OF RETORT COKE OVENS—SEIBEL.



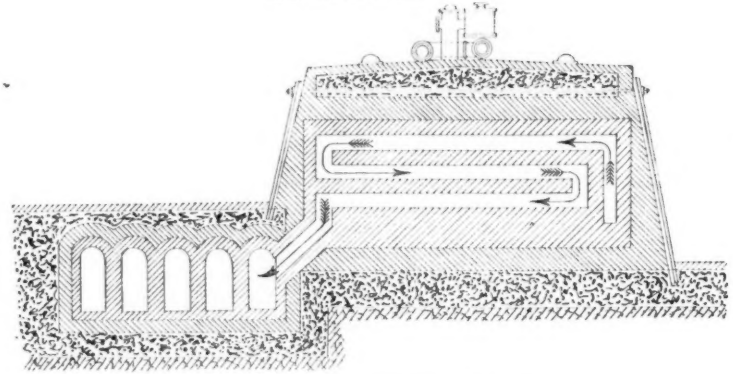
THE FESTNER-HOFFMAN COKE OVEN, WITH THE SAVING BY-PRODUCTS AND CONTINUOUS AIR HEATING APPARATUS.



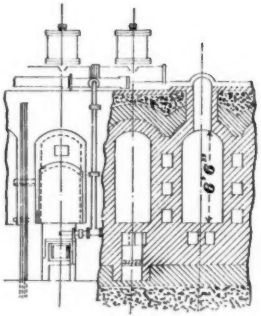
LONGITUDINAL SECTION.



GROUND PLAN.



SECTION SHOWING FLUES BETWEEN OVENS.



CROSS SECTION.

THE SIMON-CARVES COKE OVEN.

The essential elements in the physical and chemical properties of good metallurgical coke are as follows: (1) hardness of body; (2) fully-developed cell structure; (3) purity; (4) uniform quality of coke.

By hardness of body is meant the hardness of the cell walls of the coke, not density of the whole. It has been shown that carbon dioxid attacks and dissolves soft coke in its passage down a blast-furnace stack, reducing the calorific efficiency of the fuel charge and disarranging the regular operations of the furnace. Well-developed cells in the coke secure its rapid combustion, and combine with hardness of body to secure its pre-eminent value as the most vigorous metallurgical fuel. The freedom of the coke from sulphur and ash is an evident requirement; these can be reduced by modern appliances. The uniformity of quality can be governed by the manufacturer, and should receive most careful attention. The following table exhibits, approximately, the work of the three chief fuels in blast-furnace operations:

Kind of fuel.	Proximate analyses.					Size of furnace.	Per cent. iron in ore.	Pounds of fuel to 1 ton of pig iron.	Output per month gross tons.	Relative values.			Locality
	Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.					Economy.	Speed.	Purity.	
Charcoal.	3.50	6.40	87.00	3.00	tr	12′ × 60′	55	1815	3.379	100	100	100	Wisconsin.
Anthracite.	2.50	4.00	87.00	6.00	0.50	17′ × 65′	55	2244	2.698	123	80	97	New Jersey.
Coke.	0.49	0.01	87.46	11.32	0.69	22′ × 90′	59	1737	10.536	96	311	94	E. T'ms'n, Pa.

The following statement establishes the supreme value of coke in blast-furnace operations.

THE CARNEGIE STEEL COMPANY, LIMITED,
GENERAL OFFICES; CARNEGIE BUILDING,
PITTSBURG, PA., February 13, 1896.

Results obtained by the use of coke, from the H. C. Frick Coke Co. in the Edgar Thomson blast-furnaces:

As illustrating the work done, one of these furnaces produced, in one year, 140,000 gross tons of pig iron, with a coke consumption of 1,819 pounds; and, in the year following, 130,200 gross tons, on a coke consumption of 1,798 pounds. Other furnaces have produced, in one month's run, 13,353 gross tons, with a coke consumption of 1,871 pounds and 13,246 gross tons, with a coke consumption of 1,724 pounds per ton of pig.

The above-mentioned results have not been obtained at the expense of quality; for, as a matter of fact, such results can only be obtained from a furnace working under the most perfect conditions.

One furnace at these works has produced, on its present lining, 668,000 gross tons of metal, with an average coke consumption of 1,887 pounds. This includes the high consumption of fuel occasioned by several shut-downs during the past five and a half years, with the resulting period of irregular working subsequent thereto. When the

irregularities in a long campaign are considered, these results demonstrate in a very marked manner the integrity of the coke, and can only be accomplished through use of a high-grade coke which is practically uniform throughout each month in the year, —since it is a well-recognized fact that the admixture of good coke with one of inferior quality cannot produce uniform or satisfactory results in a blast furnace.

One feature of the figures given above should be well considered,—*viz.*, the consumption of coke in connection with the large output of iron. It has been demonstrated so thoroughly that, with a small volume of air, and a low output relatively to the cubical capacity, the consumption of coke is much lower than when the furnace is driven. This is necessarily the case, since the long exposure of ore in the furnace permits a very extensive removal of the oxygen by the gases,—little demand being made on the solid carbon in the charge; whereas, with rapid driving, the exposure of ore is much less, and a greater demand is made on the solid carbon, which increases the coke consumption; and, in estimating the value of a furnace fuel, the output per one hundred cubic feet of capacity should invariably be considered.

No reliable records were kept of the annual output of coke in the United States prior to 1880. But up to that time there had been a gradual increase, as shown by the number of coking-plants reported,—beginning in 1850 with four establishments, and closing in 1880 with 186. See table, page 229.

In the following table are shown the statistics of the manufacture of coke in the United States from 1880 to 1894, inclusive:*

STATISTICS OF THE MANUFACTURE OF COKE IN THE UNITED STATES, 1880 TO 1894, INCLUSIVE.

YEARS.	Establishments.	Ovens built.	Ovens building.	Coal used.	Coke produced.	Total value of coke at ovens.	Value of coke at ovens, per ton.	Yield of coal in coke.
				Short tons.	*Short tons.*			*Per cent.*
1880....	186	12,372	1,159	5,237,741	3,338,300	$6,631,267	$1.99	63
1881....	197	14,119	1,005	6,546,662	4,113,760	7,725,175	1.88	63
1882....	215	16,356	712	7,577,648	4,793,321	8,462,167	1.77	63
1883 ..	231	18,304	407	8,516,670	5,464,721	8,121,607	1.49	64
1884 .	250	19,557	812	7,951,974	4,873,805	7,242,878	1.49	61
1885 ...	233	20,116	432	8,071,126	5,106,696	7,629,118	1.49	63
1886....	222	22,597	4,154	10,688,972	6,845,369	11,153,366	1.63	64
1887....	270	26,001	3,584	11,859,752	7,611,705	15 321,116	2.01	64
1888....	261	30,059	2,527	12,945,350	8,540,030	12,445,963	1.46	66
1889....	252	34,165	2,115	15,960,973	10,258,022	16,630,301	1.62	64
1890....	253	37,158	1,547	18,005,209	11,508,021	23,215,302	2.02	64
1891 ..	243	40,245	911	16,344,540	10,352,688	20,393,216	1.97	63
1892 ..	261	42,002	1,893	18,813,337	12,010,829	23,536,141	1 96	64
1893 ..	258	44,201	717	14,917,146	9,477,580	16,523,714	1.74	63.5
1894 ...	260	44,772	591	*a*14,337,937	9,196,244	*a*12,273,669	1.337	64

a Excluding New York.

The foregoing tables exhibit in a brief, but clear, light the rapid progress of the manufacture of coke from 1880 to 1894. The product of coke for 1883 and 1884 was greatly reduced by the general business depression, which was especially disastrous to the coke consumers,—the iron and steel manufacturers.

* From Joseph D. Weeks's Report to United States Geological Survey.

NUMBER OF COKE OVENS IN THE UNITED STATES ON DECEMBER 31 OF EACH OF THE YEARS FROM 1880 TO 1894

States and Territories.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
Alabama	316	416	536	767	976	1,075	1,301	1,555	2,475	3,944	4,805	5,068	5,320	5,548	5,551
Colorado	200	267	344	352	409	434	483	532	602	834	916	948	[a] 1,128	[a] 1,154	[a] 1,154
Georgia	140	180	220	264	300	300	300	300	290	300	300	300	300	338	338
Illinois	176	176	304	316	325	320	335	278	221	149	148	25	24	24	24
Indiana	45	45	37	37	37	37	100	119	103	111	101	84	84	94	94
Indian Territory	20	20	20	20	20	40	40	80	80	78	78	80	80	80	80
Kansas	6	15	20	23	23	23	36	39	58	68	68	72	75	75	61
Kentucky	45	45	45	45	45	33	76	98	132	166	175	115	287	283	293
Missouri	0	0	0	0	0	0	0	4	4	9	10	10	10	10	10
Montana	0	0	0	2	5	2	16	27	40	90	140	140	153	153	153
New Mexico	0	0	0	12	70	70	70	70	70	70	70	[b] 0	50	50	50
New York	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[c] 12	[c] 12
Ohio	616	641	647	682	732	642	560	585	547	462	443	421	436	435	363
Pennsylvania	9,501	10,881	12,424	13,610	14,285	14,553	16,314	18,294	20,381	22,143	23,430	25,324	25,366	25,744	25,824
Tennessee	656	724	861	992	1,105	1,387	1,485	1,560	1,634	1,639	1,664	1,995	1,941	1,942	1,860
Utah	20	20	20	20	20	20	20	0	0	34	80	80	83	83	83
Virginia	0	0	0	200	200	200	350	350	550	550	550	550	594	594	736
Washington	0	0	0	0	0	2	11	30	30	30	30	80	84	84	84
West Virginia	631	689	878	962	1,005	978	1,100	2,080	2,792	3,438	4,060	4,621	5,843	7,354	7,858
Wisconsin	0	0	0	0	0	0	0	0	50	50	70	120	120	120	120
Wyoming	0	0	0	0	0	0	0	0	0	0	20	24	24	24	24
Total	12,372	14,119	16,356	18,304	19,557	20,116	22,597	26,001	30,059	34,165	37,158	40,057	42,002	44,201	44,772

[a] Includes 36 gas retorts.

[b] Coke was made in pits.

[c] Semet-Solvay ovens.

But, under all this depression, the coke manufacture has maintained a firm place in the market, increasing from 3,338,300 net tons in 1880 to 12,010,829 net tons in 1892,—a gain in thirteen years of nearly 260 per cent., or an average annual increase of 20 per cent.

The loss from 1892 to 1894, the years of greatest business depression, was nearly 23½ per cent. However, the increased output of 1895 will arrest the downward tendency, and show a large gain.

The following table gives the relative rank of the States and territories in the production of coke in the years 1880 to 1894, both inclusive:

RANK OF THE STATES AND TERRITORIES IN PRODUCTION OF COKE FROM 1880 TO 1894.*

States and Territories.	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890	1891	1892	1893	1894
Pennsylvania	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Alabama	5	5	4	3	2	2	2	4	3	2	2	2	2	2	3
West Virginia	2	2	2	2	3	3	4	2	2	3	3	3	3	3	2
Colorado	7	6	6	5	5	5	5	5	5	5	5	5	4	4	4
Tennessee	3	3	3	4	4	4	3	3	4	4	4	4	5	5	5
Virginia	....	....	..	8	7	7	6	6	6	6	6	6	6	6	6
Georgia	6	7	7	7	6	6	7	8	7	7	7	7	7	7	7
Kentucky	9	10	10	11	12	13	14	12	9	12	11	10	9	8	9
Montana	....	....	....	....	15	15	....	16	12	10	10	11	10	9	12
Ohio	4	4	5	6	8	8	8	7	8	8	8	8	8	10	8
Utah	12	....	13	....	....	....	....	....	....	19	13	14	13	11	11
Wisconsin	....	....	....	....	....	....	....	....	18	9	9	9	11	12	18
New York	....	....	....	....	....	....	....	....	....	....	....	....	....	13	10
Kansas	10	9	9	10	11	11	9	10	11	11	12	12	12	14	13
Indian Territory	11	11	11	13	13	12	12	14	15	15	14	13	16	15	19
Washington	....	....	....	....	14	14	15	11	10	17	17	16	15	16	16
Missouri	....	....	....	....	....	....	....	17	17	16	15	15	14	17	20
New Mexico	....	....	12	12	9	9	10	13	14	18	19	20	..	18	15
Indiana	....	....	..	....	....	....	13	9	13	14	16	18	17	19	14
Wyoming	....	....	..	..	....	....	....	....	....	..	..	19	....	20	17
Illinois	8	8	8	9	10	10	11	15	16	13	18	17	18	21	21

*From report of J. D. Weeks in United States Geological Survey.

In addition to its use for metallurgical purposes, coke fuel, in the past few years, has found an increasing market in domestic uses. This has been developed by a special preparation of the coke, breaking it to several sizes for use in heating furnaces and stoves, thus enabling it to take the place of anthracite coal, compared with which it gives greater economy and equal efficiency.

The outlook for the expansion of the manufacture of coke is, therefore, assured. This is evident from the large areas of coking-coal scattered over the United States, assuring a wide-spread supply at equitable and moderate cost.

While Pennsylvania, West Virginia, and Alabama are at present the great coke-producers, the table above shows the rapid growth of the coke industry in eighteen other States and territories.

The very great value of coke can be appreciated only in a moderate degree. It is only when we endeavor to contemplate the absence of

coke, with the consequent paralyses of the great metal-working industries, that its real importance can be measured.

As the United States inherits, as far as present information shows, about sixty per cent. of the world's coal-supply, with an equally liberal endowment of the ores of iron, it is manifest that, except from man's retarding policy, there can be no interruption to the onward and upward growth of these twin handmaids to the great metal industries, which contribute so largely to the civilization, happiness, progress, and power of our young republic.

NOTE.—The illustrations on pages 216, 218, 220, 222, 223, and 225 are from "A Treatise on the Manufacture of Coke and the Saving of By-Products, with Special Reference to the Methods and Ovens best adapted to the Production of the best Coke from the Various American Coals," by John Fulton, E. M. Published by The Colliery Engineer Co., Scranton, Pa. Price $4.00.

DEVELOPMENT OF ELECTRIC LIGHTING ENGINES.*

By H. Lindley.

THE engines to which this paper refers are what we may call ordinary engines,—*viz.*, having cylinders, pistons, etc.,—and the speed referred to is the speed of rotation of the crank-shaft. Another speed very frequently referred to when speaking of steam engines is that known as piston speed; it should be strictly known as mean or average piston speed; but plain piston speed is enough for our purpose, being a term familiar to you all, and well understood. Now, it is rather a singular thing that this piston speed varies but slightly in the various classes of engines we are now considering. You are just as likely to find a high piston speed in a slow-speed engine as you are in a high-speed one,—if anything, rather more likely; there is then some connection of the inverse kind between rotation speed and piston speed, and that is, of course, the stroke; that is to say, the slow-speed engine has a long stroke, the moderate-speed a shorter stroke, and the high-speed a still shorter stroke. Now, I do not think I need make any attempt to discover and tell you what are the advantages or the objections to slow or high speed; it does not enter into the object of this paper to do so, and no doubt you are as well aware of them as I am, or better.

All I wish to say is that, *per se*, slow speed has certainly obvious objections; and yet, for some reason or other, slow-speed engines are to-day still much used for driving high-speed electric-lighting machinery. Now, I do not think it difficult to find an adequate reason for this, and that is that it is in the nature of a legacy from past ages.

Now, as soon as it became evident that the newly opening-out field of electric lighting was likely to require the services of a large number of small-sized steam engines, nearly every maker of them suddenly awoke to the fact that his particular make of engine was particularly suited for electric-lighting work, and advertised the fact.

The wish, however, was but father to the thought, and, as soon as one of these engines was set to do the work that by calculation it should be equal to doing, and which also by exact calculation it was known to have to do, the crank-pin got hot. An extra large sized lubricator

*Abstract of a paper read on February 24, 1896, before the Northern Society of Electrical Engineers.

was fitted to the crank-pin, and the engine was advertised as being specially designed and equipped for electric-light work. But still it did not do. Why, then, did engine-builders still persevere till they did produce an engine that would do the work it should do, when all the time there was the slow-speed mill engine waiting and willing to do it? I have said it was too large; so it was, but it would not have been difficult to make small copies of it, and then the thing would have been done. Apart from other reasons, there was, of course, the great question of cost; the slow-speed engine was too dear.

This, then, leads us to the birth of the moderate-speed engine,—that is, the modern moderate-speed one, and one that would really do without flinching the work that calculation showed it capable of doing, and keep on at it for considerable periods of time.

The thing was not so difficult after all, but it wanted doing, and, like many other things of which that may be said, it took time to do. Firstly, the stroke wanted shortening,—that to a certain extent had already been done,—and, secondly, the bearings wanted increasing. Here makers proceeded timidly, and it was some time before a correct proportion was arrived at. And no wonder, when we come to consider the great amount by which such bearings did require increasing. Take as an example an engine with an 8″ cylinder, or say 6 horse-power nominal. This engine now has a crank-pin as large as that used in a 16″ cylinder, or 25 horse-power normal of the slow-speed type not many years ago, or of to-day as made by many makers. The piston speed is about the same in both cases, but the cylinder ratios are as 1:4. True, the smaller cylinder has frequently to stand a rather higher pressure of steam than the older engine, but the difference is not enough to account for all that difference in the size of the crank-pins. What, then, was the cause? Why, as you will guess, the greater number of revolutions; that is the indirect cause, the more direct cause being the tendency to knock out at the higher speeds, and thus displace lubricants. The main bearings have not increased in the same ratio, and for one reason,—*viz.*, that, owing to the speed being higher, the flywheel can be much lighter and smaller.

Lubrication then also became a most important question; the extra large-sized lubricator on the crank-pin had to be abandoned, because it could not be filled while the engine was running, and in its place some continuous method of supplying oil was adopted. A whole crowd of wick or screw adjustment oilers has in most good engines now been replaced by a central oil box with a pipe to each important bearing, and having a slight drop arrangement at the box, so arranged that the supply can be cut off without altering the adjustment.

Another important detail that has led to the success of the modern

moderate-speed engine is by no means a new one,—it is only the almost universal adoption of it in this class of engine that is new,—and that is the use of white metal in the bearings. I believe it is not too much to say that the fast-running engines of the present day, including marine and locomotive engines, in addition to those we are now considering, would be almost impossible without the use of white metal. There are many makes on the market, and many good ones, I believe, but, to go no further than the old Babbit metal, the advantages of its use over brass or bronze are many. Not only is it much less ready to take offence at any small particle of dirt that may get into the bearing, and get hot, but it wears longer; and moreover, by use, puts a polish on the pins or journal of the shaft that not only necessitates less oil being used, but must also reduce internal friction in the engine. In heavily-loaded bearings, such as cross-head pins, etc., a quality must be used of sufficient hardness not to pound out.

Then we have another set or class of improvements that were necessary, and have been, or ought to have been, incorporated in the moderate- or high-speed engine of to-day, and I refer to various fastenings about the engine. For example, some years ago when the firm of which I am a member first began to make engines that we fondly hoped were perfect for electric-lighting work, we had the lock-nuts of one of the connecting-rod big end bolts in a small engine jar off whilst working. The lock-nuts were good enough for the old slower speeds, and then you could stop and tighten them if you heard the engine pounding badly through their coming loose, but they would not do for electric lighting. Nothing more serious than a stoppage (quite bad enough I admit) happened in this case, but from that date we abolished lock-nuts throughout the engine (except on main bearings), and used other and more secure devices in their stead.

Slide valves used to be secured on their spindles between lock-nuts in the old days,—a doubly-bad arrangement. No doubt many of you can recollect trying to tighten these at some now distant date with two keys (both too thick) and some pieces broken off the end of a file by way of packing, or with a hammer and chisel, and how the spindle used to spring when you tried to hammer against the nut on it. Apart, however, from the difficulty of tightening the lock-nuts in the valve chest of an engine, they were bad because of the small amount of surface they exposed for driving the valve. Knocking thus took place early at this part, and this tended still more to loosen the nuts. The cross-head and its guide too were in the early days unsatisfactory. In the first place, unless the pin or gudgeon was too small, as it generally was, the cross-head was too heavy, the most frequent construction of forming the fork in the cross-head and fitting the brasses in an

eye in the connecting rod not allowing of a very satisfactory job being made of the cross-head if lightness was attempted, unless the pin was made rather short in the bearing. To obtain a wide pin and at the same time a light cross-head, the plan is now almost universally adopted of forging the cross-head on the piston rod, thus saving the heavy boss, and avoiding the risk of the cotter giving out if water were met with in the cylinder, and forking the rod, by which means a wide pin and a light cross-head are obtained.

A word should also be said about pistons; not that there have been any very radical improvements made in them of late years, but rather that of the types to hand the most suitable should be chosen, and, moreover, the choice should be carefully made.

Cast-iron rings wear very well, if made of good material; but unfortunately they do not lend themselves, at least in the ordinary form, very well to use with a solid piston body, which is much to be preferred to one made with a junk ring, in an engine running at moderate or high speed. The ordinary pattern of piston, solid if over sixteen inches or so in diameter, or made with a junk ring if less, with two cast-iron rings expanded by an inch coil, answers very well for slow or very moderate speeds, but it is certainly advisable to avoid the screws necessary where a junk ring is used, and also to reduce as much as possible ring friction, which with the above construction is probably always more than necessary.

Another point that deserves attention is the valve. This may be either of the flat or piston type. The flat valve has the advantage of cheapness and steam tightness, but it takes more power to drive than the piston valve, and that is a consideration where automatic expansion by means of a shaft governor is used, as it always should be. It does very well, however, with low pressures of steam, and, if made with a trick port, gives good openings to the cylinder, and that without excessive travel. In the low-pressure cylinder of a compound engine it is advisable to carry the spindle through the valve chest, so as to afford a double bearing for it and to fit a spring between the spindle and the valve, as by this means the annoying clattering present when running non-condensing on light loads is avoided.

Undoubtedly the best construction is a well-fitting solid valve, without packing of any sort. The liners should be most carefully bored out to attain this result, ordinary boring not being good enough unless lapped out afterwards; and this is not very advisable, as it is impossible to get out all the emery used in lapping. The valve should be ground and polished to a perfect fit, and then, as long as that condition of fit lasts, you have the best valve. But unfortunately that condition is not an everlasting one, and there is, therefore, a

great temptation to fit some form of spring packing. The objection to spring packing is that the liner gets worn as much as the rings, and, when it becomes necessary to renew the valve, it is like "putting new wine into old bottles"; they do not go well together.

I have now reviewed most of the points that have required attention at the hand of engineers in adapting the moderate-speed and still most extensively-used engine to the needs of electric-lighting work. I have not, however, entered into the question of governing, beyond suggesting that a shaft governor should be used, altering the angular lead and throw of the eccentric so as to vary the cut-off and compression I think I ought, however, to give some reason why a shaft governor is to be preferred to one operating a throttle valve; but, before doing so, I might refer to one feature of the throttle-valve governor wherein it is superior to the other, and that is the ease with which its speed may be altered whilst the engine is running. A speeding device for a throttle-valve governor usually takes the form of a supplementary spring attached to some moving portion of the governor operating the valve. When tension is put on this spring, an extra resistance is added to that restraining the opening of the governor balls, and thus more speed is required to get them out, and the engine has to run faster to do so, and *vice versa*. Speeding gear, it is true, can be fitted to a shaft governor, but it is nothing like so simple a matter; on the other hand, the advantages of a shaft governor controlling the cut-off are many and manifest. First, the great objection to a governor belt is entirely removed; this can also be secured in a throttle-valve governor, and in two ways. The governor may either be driven by a pitch chain, or it may be mounted on the shaft of the engine and its motion transmitted to the valve by means of a system of levers.

Then, again, on the mere question of governing,—that is, close regulation of speed,—the shaft governor has the advantage, and for the reason that the compression of the exhaust in the cylinder is varied at the same time that the cut-off is altered.

I was careful just now to say "an engine fitted with a shaft governor and a single valve," and it was necessary to do so, as there is another way of using a shaft governor, and that is with two valves. A main valve is used in this case, driven by a fixed eccentric, set to give the latest cut-off and compression required. The cut-off valve works on the back of the main valve, and its eccentric is loose on the shaft and under control of the shaft-governor, but this eccentric is merely rotated round the shaft to obtain the various points of cut-off,—that is, it has its angular lead only altered, and not its throw. This method of governing, which has for its first disadvantage the

multiplication of parts necessary to operate two valves, has also the same disadvantage as the throttling method,—*i. e.*, the fixed compression,—but it has also another special one of its own, and that is, if any steam is admitted at all, it is of high pressure, and, even if it be cut off at the dead center, the clearance will be all filled, and enough steam get in to make the engine run away. Now, just as I said at the commencement of this paper that, *per se*, slow speed is a disadvantage, so I must now say that, *per se*, high speed is a great advantage, and for the simple reason that direct communication with the dynamo is possible, and all other means of transmission are avoided. It is not very likely that any great increase in speed over what at present obtains will be attained,—that is, in engines of the class we are considering, or where there is rubbing contact.

The high-speed engine can no doubt be made very economical, if only on account of its high speed, and the consequent higher temperature of its cylinder walls, but it is more susceptible to derangement from careless use, and, if a breakdown of any part should occur, the results are more disastrous than in a slow speed engine. Water, in particular, is a source of the greatest danger, and a separator is therefore usually fitted to this class of engine.

There is, however, one point to which I should like to call attention before bringing this paper to a close, and that is that, in addition to the electrical industry having created a demand for a new and improved race of engine attendants,—that is, at any rate, so far as land practice is concerned,—the old easy-going mill-engine tender, with hardly a care to trouble him, has, in central electric-light stations, had to give way to a man who is constantly on the watch lest anything should go wrong, and who is alive to the importance, with others about the station, of maintaining a steady and uninterrupted working of the plant under his charge. Marine engineers knew what this meant better than those in charge of stationary engines; but the advent of high-speed steam and dynamo electric machinery, that must be kept going, has necessitated vastly-increased watchfulness and care from those in charge to what obtained only a few years ago.

ARE BRITISH RAILROADS GOOD INVESTMENTS?

By Thomas F. Woodlock.

ONE of the most remarkable developments of that period of dull times and excessive demand for good investments which followed upon the Baring crisis of 1890 is undoubtedly the enormous advance that has taken place in the prices of all British railway stocks that yield any return at all. This advance really dates from Mr. Goschen's famous conversion of British consols into a 2¾ per cent. stock, which eventually became a 2½ per cent. stock. The first impetus to prices came from the rush of investors, who were confronted with a reduction of interest on their holdings in British funds, and sought to invest their money elsewhere, so as to avoid loss of income. This drove British railway debenture stocks, guaranteed stocks, "preference" stocks,—in fact, all stocks of fixed yield, with priority of claim over "ordinary" stocks,—to what were then considered extremely high prices. As many will remember, it also inaugurated an era of speculation.

When the Baring crisis came, shutting off all channels of foreign investment and severely checking speculation everywhere, the demand for these stocks became more urgent, because the savings of the country had to find investment at home. This inaugurated a period of steady absorption of stocks, not merely those with "priority of claim, but also "ordinary" stocks of the best roads. Certain stocks,—such, for example, as "Brighton A" or "Deferred,"—which were wont to be the speculative footballs of the Stock Exchange, were gradually taken off the market by investors, and the floating supply became smaller and smaller, so that they lost their speculative character to a large extent.

Interrupted only by a severe coal miners' strike in 1893, the process of "breaking records" went on, and stock after stock, especially of the priority class, sold at the highest prices ever known. Most of the leading railroads converted their 4 per cent. debentures into 3 per cent. debentures for the convenience of investors, issuing, of course, nominal capital in compensation for the decreased interest. There was also started, and somewhat extensively practised, a system of "stock splitting," by which a high-priced stock, paying, say, six or seven per cent., was split into a "preferred" and "deferred" stock,

each of equal amount with the original. This provided, in place of the cumbrous and high-priced stock, two stocks,—one with a fixed yield, the other with an uncertain yield representing future prospects. Companies were even formed to carry out the splitting process, where the railroads were unwilling to do it themselves.

British railway stocks now enjoy a favor in the eyes of the British investor to an extent which it is difficult for us to conceive. They are looked upon as "gilt-edged" investments, much as we look upon the highest class of municipal or State bonds, and even the "ordinary" stocks, the return on which must necessarily fluctuate from year to year, are bought by investors for their yield. A recent list of prices, showing the yield per cent. to the buyer, gives the following extraordinary results.

British railway debenture stocks—that is, the highest class of security, being a first charge on earnings—sell, on an average, at prices which yield the investor barely 2¾ per cent. Many yield only 2⅝ per cent., and some even less.

British railway "guaranteed" stocks sell on about the same level, yielding the investor about 2¾ per cent. Some yield less.

British railway "preference" stocks, at present prices, yield the investor, on an average, 2⅞ per cent. British railway "ordinary" stocks which pay dividends (and almost all pay something) yield the investor between 3¼ and 3⅜ per cent., or rather less than the fortunate bidders realized from the last United States 4 per cent. loan.

Such prices as these argue an extraordinary confidence on the part of the buyer in the safety of the security and the permanence of the yield. Is this confidence justified by the facts? Are British railroad stocks good investments in the highest sense?

The railroad system of Great Britain is, of course, from our point of view, small. It consists of about 21,000 miles of main track. For the purposes of this article the Irish railroads are included. As might be expected, however, the roads are very costly, and very perfect of their kind, and they carry a very dense traffic, both of freight and passengers. Consequently, they earn a very large amount of money per mile of road. As is shown in the appendix (Table B), the gross earnings per mile of road are about $19,000, the expenses about $10,750, and the net earnings more than $8,000. Without attempting to institute further comparison (which would be very misleading), it may be mentioned that on our railroads gross earnings per mile average about $6,000, operating expenses per mile $4,200, and net earnings per mile $1,800. This gives a fair idea of the relative density of business, although it must be remembered that freight rates in Great Britain are at least twice as high as in this country.

The first thing that strikes one, on investigating the statistics of the railroads, is that in the last few years they have absorbed a very large amount of capital, without a corresponding increase in mileage.

The second thing—even more striking—is that this increase in capital has not produced a proportionate increase in net revenue. The third (necessary consequence of the preceding) is that the average return on British railroad capital shows a tendency to decrease. These are three very important facts bearing on the character of this capital as an investment.

The theory of investment in railroad stocks or bonds seems to demand that the first charge upon earnings shall be such a sum as shall meet all purely operating expenses, and shall maintain and renew the plant, so that at the end of each year it shall be at least as efficient, and, therefore, in at least as good condition, as at the close of the preceding year. If, after these charges are met, the residue shows a tendency to increase, the investment is good. If the tendency be in a contrary direction, the investment is not good.

It seems clear, also, that it is necessary to the justification of fresh capital expenditure upon a railroad that it shall result in proportionately increased net revenue, after operating expenses and maintenance of plant are fully satisfied. Otherwise the expenditure does not pay. Clearly, also, capital expenditure which simply prevents decreased net revenue, or results in a disproportionately small increase in net revenue, is not justifiable, because either it is unproductive altogether, or else it partakes of the nature of "maintenance" expenditure.

Ten years ago British railroads were capitalized at approximately $212,605 per mile (see appendix, Table A); at the end of 1894 they were capitalized for approximately $235,600 per mile. The increase in the ten years was $22,995 per mile, or about 10½ per cent. The increase in gross earnings per mile in the same period was from $17,385 to $19,100, being $1,715 or rather less than 10 per cent. The increase in net earnings, however, was from $8,145 to $8,350, only $205, or about 2⅝ per cent. (see Table B, appendix). Allowing for the nominal increase in capital, resulting from conversions in the period 1885-1894, it is probable that "paid-up" capital per mile increased by at least 5 per cent., and probably more. Yet, with the natural growth of business that would necessarily show itself in a country like Great Britain, net earnings of the railroads have not increased proportionately with the increase in capital.

Reference to Table C in the appendix shows that, as compared with ten years ago (and in a very marked way since 1889), the return per cent. on British railroad capital has decreased. The total amount distributed in 1894 was almost exactly the same as in 1889, but the

yield per cent. on the capital was 0.45 less. In the case of "ordinary stock," the return on which is shown separately, the distribution in 1894 almost exactly equalled that of 1888, but the return per cent. on capital in 1894 was nearly ⅞ of 1 per cent. less than in 1888. In a general way, it may be said that capital invested in British railroads in the last ten years has been less productive than capital invested previously; the tendency has been for the yield to diminish. Notwithstanding this, capital as we have seen, has been freely invested. In the ten years 1885-1894 the increase has been $919,114,940. Of this we may deduct, say, $450,000,000 for nominal increase, as a result of conversion and "stock splitting," which leaves $459,000,000 actually paid up. By the issue of this capital the railroads have received in actual cash about $600,000,000, as most of the new capital has been sold at high premiums. It is curious to note that the whole of these dividends distributed on the "ordinary" stocks in the period amount to only $676,000,000, and that the railroads have really borrowed as much in new capital as they have paid in dividends on the ordinary stocks.

Why have they borrowed so much money? It is not for new mileage, because the capitalization per mile has increased by 10 per cent. It is not for productive "improvements and additions," because proportionately increased productiveness is lacking. An addition which does not increase revenue or diminish expenditure is not a proper capital charge, according to the best modern practice in railroads. That which simply tends to *hold* business, and not to *increase* business, is a proper charge against *operating expenses*.

We may measure the efficiency of a steam hammer by the price and frequency of its blows. In like manner we may measure the efficiency of a railroad by the number of train-miles run producing revenue, and the amount of revenue produced by each train-mile. If we spend money constantly on the steam hammer, and find its blows increasing in frequency, but diminishing in force in greater proportion, the net efficiency of that hammer is decreasing, and our capital expenditure thereon is not productive or justifiable. If, in like manner, we spend money on a railroad, and find its revenue train-mileage increasing, but the net revenue per train-mile decreasing in greater proportion, so as to diminish the yield on all the capital invested, clearly our expenditure is not justifiable.

We find these railroads making a smaller return on invested capital year by year; we find them earning less in gross for every revenue train-mile run, and spending more per train-mile. The actual increase in paid-up capitalization per mile of road, discarding the nominal increase for conversions, is about 5 per cent. in ten years. As a

result of this, the increase in the number of train-miles run per mile of road is from 14,338 to 15,928, or about 11 per cent. So far, so good. The decrease in gross revenue per train-mile (see Table D, appendix) is only about 0.66 of a cent,—a trifling matter. The operating expenses, however, show an increase of 3 cents per train-mile in the ten years. This is equal to about 5 per cent., and the result is a decrease in the net earnings per train-mile of 4 cents, or about 7¾ per cent. Here is evidently the trouble.

A railroad's operating expenses may be divided into "maintenance" charges and "other" charges. The peculiarity of "maintenance" items of expenditure is that, to a very large extent, they are subject to arbitrary changes from year to year, independent of the volume of business done. A locomotive may be left unrepaired; freight cars may be broken up and not replaced; steel rails, if not in absolutely dangerous condition, may be left another year in track; renewals of ties may beskimped, at a pinch, to svae money temporarily; replacement and renewal of bridges, ballast, etc., can all be deferred, if need be.

Labor and fuel, however, in conducting transportation, cannot be curtailed without curtailing train-mileage, for they are absolutely necessary for the running of trains. These items depend rigidly on the volume of traffic, and must vary almost directly with it. They are "compulsory" items, while we may term the other items of expense "optional" items.

Now, we have to deal with a sharp increase in operating expenditure on the British railroads,—an increase which has practically nullified the gross increase per train-mile, and has greatly decreased the net earnings per train-mile. It is this increase which has reduced the yield on capital, because the increase in gross earnings was proportionately equal to the increase in capital. Had expenses increased only proportionately, the net earnings would have increased proportionately, and capital would not have had to suffer a reduced yield. The increase in gross earnings was, however, obtained only by increasing the train-mileage in a slightly greater proportion, and each train-mile earned slightly less in gross than before. On the other hand, each train-mile was much more expensive than before.

Other things being equal, the 333,000,000 train-miles run by the British railroads in 1894 should have cost slightly less per train-mile than the 275,060,000 train-miles run in 1885, because certain items of expenditure are fixed and do not vary with the train-mile. Yet (according to Table D) each train-mile in 1885 cost 61.8 cents, and in 1894 each train-mile cost 64.8 cents. This cost divided itself into the following items in each year (see Table E):

	1885.	1894.
Maintenance of way	11.0	10.9
Motive power	16.4	18.1
Maintenance equip't	6.1	5.7
Other expenses	28.3	30.1
Total	61.8	64.8

Separating the "optional" expenses from the "compulsory" expenses (according to our classification), we find:

"Optional" decreased	0.5
"Compulsory" increased	3.5
Total increased	3.0

Taking the 1894 figures against the 1889 (for a reason to be explained), we find:

Maintenance of way increased	0.5
Motive power increased	1.5
Repair of cars decreased	0.2
"Other" expenses increased	2.0

or, adopting our own classification:

"Optional" expenses increased	0.3
"Compulsory" expenses increased	3.5

Practically all the increase in expenditure between 1889 and 1894 has been in items which vary directly with the volume of business done, and are not subject to arbitrary increase or decrease. It takes as many men, pounds of coal, pints of oil, and pounds of waste, to run a locomotive, no matter how much the prices of these articles vary. It does not necessarily involve the same amount of work on permanent way, rails, bridges, cars, or other structures, as these expenditures can be deferred, or otherwise met. Examination of expense for "labor," in the case of railroads accounting for 75 per cent. of the total mileage of Great Britain (statistics for all, and for these prior to 1889, not being available), shows that between 1889 and 1894 the following changes occurred in each department of expenses:

In maintenance of way cost of labor increased			14	per	cent.
" motive power	"	"	23	"	"
"locomotive renewals (included in "motive power" in previous tables)	"	"	11	"	"
" maintenance of cars	"	"	9	"	"
" traffic department	"	"	19	"	"

Reference to Table A (appendix) shows an increase in mileage between 1889 and 1894 of exactly 5 per cent. The increase in train-miles per mile of road in the same period was 729, or 4.8 per cent. Clearly, therefore, while additional men were taken on, the wages of all must have risen decidedly.

Now, the expenditure on coal and coke, and material for repairs, renewals, and maintenance, was as follows between 1889 and 1894 on the same road :

In maintenance of way cost of material increased 1.5 per cent.
" motive power " coal and coke " 32 " "
" locomotive renewals " material decreased 1 " "
" maintenance of cars " " " 2 " "

From this it seems that the work done, as represented by cost of actual material used in repairs and renewals of cars and repairs of locomotives, was less in 1894 than in 1889, although it cost more. The cost of fuel increased enormously, in response to a higher price and increased train-mileage. Only the items of renewals and repairs of locomotives and cars show a decrease, but the increase in material used in maintenance of way is very small, and less than the increased mileage would call for.

In a word, the railroads seem to have been compelled to spend so much more money to run their trains that they economized on the repairs and maintenance of their property.

Mileage increased 5 per cent., but material used in repair of permanent way increased only 1.5 per cent., although train-miles increased 4¾ per cent.

The number of locomotives owned by the railroads *increased* 13 per cent. in the period 1889 to 1894, but the material used in their repair *decreased* 1 per cent.

The number of cars owned *increased* about 13 per cent. in the same period, but materials and repairs *decreased* 2 per cent.

Even "labor," the actual cost of which has risen, shows a smaller increase in cost in the repair of equipment than the increase in the amount of equipment.

The meaning of all this is that the increase in expenditure on the British roads, which has been so far the direct cause of the decrease in the yield on capital invested, has evidently been forced upon the railroads, and has been accompanied by no corresponding increase in efficiency. On the contrary, it has itself forced upon the railroads economy in the items of "maintenance, repairs, and renewals," and has resulted in less work being done in these departments.

Either the railroads have been less perfectly maintained than before, or else the money for their maintenance comes from sources other

than operating expenses,—*i. e.*, from capital. It is certain that operating expenses have in the last few years been charged with proportionately smaller sums for "maintenance" than in the past.

What are we to conclude from this? We see capital being poured into these roads year after year in never-ending supply; we see the yield per cent. on capital diminishing steadily; we see the ratio of operating expenses to earnings steadily increasing, in spite of smaller expenditures in all maintenance departments: what is the only logical conclusion? Is it not that capital expenditures are doing work that should be done by operating expenses; that "*improvements and additions*" (which the auditors appointed by the stockholders semi-annually insist shall be charged to capital, in accordance with a law that they themselves did not make, but must administer) are, in reality, "*maintenance*" and "*maintenance*" alone, inasmuch as they do not increase net earnings?

Furthermore, must we not conclude that the time cannot be far distant when the ratio of operating expenses will advance further, because absolutely necessary "maintenance" expenditure must be made, which can in no manner be charged to capital? The "optional" expenditures are "optional" only for a time: eventually they become "compulsory." Where will then be the already decreased yield on British railroad securities?

Surely it is time that British railroads begin to think of closing "construction accounts" finally and absolutely, according to the most enlightened American practice. It ought to be the business of stockholders to insist on this, in their own interests, as their dividends are slowly becoming more diluted year by year; in fact, as we saw, "ordinary" dividends are being borrowed by the railroads as fast as they are paid. Until this is done, we can hardly see how British railroads can be called good investments.

APPENDIX.

The following figures are taken in all cases from the British Board of Trade "Blue Books" on the railroads of Great Britain, issued annually. The latest issue covers the calendar year 1894. In turn-

ing pounds, shillings, and pence into dollars and cents, the arbitrary, but convenient, rates of £1=$5 and 1d=2 cents have been adopted.

TABLE A.

(*Showing the number of miles of main track, the total capitalization, and the capitalization per mile of main track from 1885 to 1894.*)

	Miles of road.	Capitalization.	Cap'n per mile.
1885	19,169	$4,079,290,275	$212,605
1886	19,332	4,141,721,270	214,240
1887	19,578	4,229,858,270	216,050
1888	19,812	4,323,479,815	218,225
1889	19,943	4,382,975,530	219,775
1890	20,073	4,487,360,130	223,550
1891	20,191	4,597,125,605	227,680
1892	20,325	4,721,786,600	232,315
1893	20,646	4,856,616,765	235,235
1894	20,908	4,926,436,775	235,650

TABLE B.

(*Showing the gross earnings, operating expenses, and net earnings per mile of road for each year from 1885 to 1894.*)

	Gross earnings.	Operating expenses.	Net earnings.
1885	$17,385	$9,240	$8,145
1886	17,230	9,080	8,150
1887	17,345	9,110	8,235
1888	17,600	9,180	8,320
1889	18,480	9,670	8,810
1890	19,065	10,350	8,715
1891	19,405	10,760	8,645
1892	19,320	10,835	8,485
1893	18,610	10,620	7,990
1894	19,100	10,750	8,350

TABLE C.

(*Showing the present classification of capital of British railroads, and the yield thereon in gross and per cent. for ten years 1885-1894.*)

I.—CLASSIFICATION OF CAPITAL, 1894.

"Loans" and debentures	$1,362,757,935
"Preference" and guaranteed	1,764,245,420
"Ordinary" or common	1,800,433,420
	$4,926,436,775

II.—YIELD ON CAPITAL.

	Dividends on ordinary.	Do per cent.	All dividends.	Do per cent.
1885....	$ 61,114,140	4.04	$ 168,341,185	4.13
1886....	60,196,580	3.94	168,965,830	4.08
1887....	64,163,875	4.08	174,522,285	4.13
1888....	68,079,985	4.22	180,143,795	4.17
1889....	76,049,635	4.66	189,263,540	4.32
1890....	74,944,320	4.51	190,054,175	4.24
1891....	72,168,285	4.24	188,658,700	4.10
1892....	69,211,405	3.98	187,805,890	3.98
1893....	62,104,150	3.51	181,724,145	3.74
1894....	68,499,725	3.80	190,549,215	3.87
Total,	$676,532,100		$1,820,028,760	

TABLE D.

(*Showing the gross earnings, operating expenses, and net earnings per "revenue train-mile" for the ten years 1885–1894.*)

Gross per tr. mile.	Op. ex. per tr. mile.	Net per tr. mile.
$1.160	$0.618	$0.542
1.160	0.608	0.552
1.160	0.604	0.556
1.150	0.598	0.552
1.165	0.610	0.555
1.160	0.644	0.516
1.170	0.636	0.534
1.150	0.644	0.516
1.145	0.652	0.493
1.150	0.648	0.502

TABLE E.

(*Showing the classification of operating expenses per train-mile for the years 1885-1894.*)

	Maintenance of way.	Motive power.	Maint. of cars.	Other exp.
1885....	11.0 cents	16.4 cents	6.1 cents	28.3 cents
1886....	10.4 "	16.1 "	6.1 "	28.2 "
1887....	10.3 "	15.9 "	6.1 "	28.1 "
1888....	10.2 "	15.7 "	6.0 "	27.9 "
1889....	10.4 "	16.6 "	5.9 "	28.1 "
1890....	10.7 "	18.2 "	6.0 "	28.7 "
1891....	10.8 "	18.9 "	5.9 "	28.8 "
1892....	10.8 "	18.4 "	5.9 "	29.3 "
1893....	11.1 "	18.3 "	5.8 "	30.0 "
1894....	10.9 "	18.1 "	5.7 "	30.1 "

ELECTRICITY AND THE HORSELESS-CARRIAGE PROBLEM.

By Wm. Baxter, Jr.

THE great interest in automobiles that is being displayed, at the present time, not only in this country, but in all parts of Europe, is strong evidence that the era of the horseless carriage is close at hand. It is a very common belief that inventions come first, and the demand for them follows, as the result of energetic efforts on the part of their promoters. This is true in most cases, but very often the demand exists long before it is satisfied. Inventions, therefore, may be divided into two classes,—those that are due to the stimulus of a long-existing demand, and those that create a demand by the force of their intrinsic merits. Those who develop the first successful inventions of the former class, as a rule, reap a golden harvest; and it is on this account that those engaged in such work display so much activity. Sometimes the demand is not so great as to induce inventive genius to put forth its greatest efforts, and then development goes along slowly, until a conviction is formed in the minds of men that it is about time for the want to be satisfied. Then inventive genius attacks the problem with such determination that success is soon attained. This may be said to be the stage that the automobile problem has reached at the present time.

The problem has remained unsolved, so far; not because in making a self-propelling vehicle there is any difficulty insolvable by well-known methods, but because no one has succeeded in removing the objectionable features that have characterized all such devices.

Steam wagons have been made from time to time for the last thirty or forty years,* and many of them were very successful, so far as their ability to run up grades, or attain a high speed, was concerned, and, in point of economy of operation, were far ahead of horses. But, notwithstanding such success, they have not come into use, because their objectionable features overbalanced, by far, their advantages.

For the purpose of propelling the general run of vehicles, it may be safely said that steam will never be made acceptable. It will furnish all the power required for the purpose, and at a very economical rate, but it is dirty, noisy, more or less dangerous, and requires so much attention that it would be almost impracticable for one man to run a steam wagon through the busy streets of a city.

* The earliest historical records of efforts to propel vehicles by steam date back more than one hundred years, but nothing worthy of mention was done previous to 1855 or 1860.

The improvements that have been made in gas and oil engines within the last ten or fifteen years have led many to believe that one or the other might succeed in solving the horseless-carriage problem; but those who have devoted themselves to investigating the possibilities of electricity do not entertain such opinions, and it is proposed to show in this article that electricity, which vanquished all competitors in the street-railway field, can achieve as great success in the propulsion of wagons, bicycles, or any other form of vehicle.

No one can question the ability of oil or gas engines to furnish power sufficient to run a wagon under ordinary conditions, as this fact has been well demonstrated. But the mere ability to furnish the energy required does not constitute a successful solution of the problem. Steam can do this much, but yet has failed to meet the case.

Many attempts were made to solve the street-car problem by the use of steam; but all failed, notwithstanding that some of the best engineering talent of the day grappled with the subject. Gas and oil engines also have been tried in this field, but their success was no greater,—in fact, not as great.

When electricity came into the field and achieved a complete success, the advocates of gas and oil engines put forth their greatest efforts, in the hope that the excitement of the moment, caused by the overwhelming victory of the trolley-car, might enable them to get at least a slight foothold. But their failure was absolute; and, so far as the street-railway field is concerned, oil and gas engines have sunk into oblivion. Now, what is true of street cars ought to be equally true of automobiles, as the only difference between them is that the former run on rails, while the latter do not.

If we look into the history of street railway cars, and also that of self-propelling vehicles, we find that many attempts to meet the requirements in both cases have been made with gas and oil engines, as well as with steam. In the street-car field we find that in no case was the success attained so great as to convince railroad managers that it would be wise to discard their horses; and the success of the vehicles has been sufficient only to convince those interested in such matters that eventually some form of motor will supersede animal power.

Efforts to solve the horseless-carriage problem by the use of steam engines have been made for at least forty years, and by oil and gas engines for fifteen years, if not more. Steam has failed completely. Gas and oil engines have attained a limited success, but their performance has not been such as to awaken any great enthusiasm, although it has served to induce a very general belief that a complete and entirely satisfactory solution of the problem is very near at hand.

In order to be able to determine whether it is probable that this

solution will be effected by either gas or oil motors, it will be well to look into the steam engine, and see why it has failed; then we shall be better able to decide as to the probability of removal of its objectionable features by the use of gas or oil engines.

Steam has failed for the following reasons: first, the maximum horizontal effort it is able to impart to the vehicle is limited, and is not much greater than that developed when the engine is working at its normal full load capacity; second, the attention required by the boiler is such that one man cannot very well look after it and also operate the vehicle; third, if the boiler is neglected, the fire will go down, or the water will get too low, necessitating a halt until the proper conditions are restored; fourth, a skilled attendant is required to reduce to a minimum the danger of explosion; fifth, there is more or less danger of setting fire to the vehicle, or to the building in which it is kept; sixth, the steam and hot water that always manage to leak out at one place or another not only are disagreeable, but may damage the wagon or its contents; seventh, the vehicle is dirty, because of the necessity of lubricating the large number of working joints in the mechanism, and emits a disagreeable odor, because the lubricating oil on some parts of the engine becomes very hot; eighth, as the engine cannot be perfectly balanced and must run at a high velocity, its racking effect on the supporting framework is great, necessitating extra strength and weight.

Of all these objections, the most serious are the inability to put forth an extraordinary effort when occasion requires it, the practical impossibility of running the vehicle through crowded streets with one man, the excessive weight and strength of supporting frame, and, finally, the uncleanliness and disagreeable odor.

The inability to largely increase the horizontal effort is a fatal defect, which can be overcome only by using an engine of much greater capacity than would be required for the average work. That this is true will be admitted at once, inasmuch as the horizontal effort, or torque, of the driving-wheels is proportional to the pressure exerted by the steam in the cylinder, and this can be increased above the normal amount only by the difference between the maximum pressure obtained with steam following the piston full stroke and the average pressure when the engine is cutting off or throttling to the extent necessary to develop the maximum working capacity. If the engine capacity is sufficient only to meet the ordinary requirements, it will fail whenever called upon to meet extraordinary obstructions, and, as a result, the vehicle will be frequently stalled. Although the engines are generally made of greater capacity than that required for ordinary purposes, they have, perhaps, never been made large enough to cope with every emergency. It is doubtful if a steam wagon was ever made that did not at

some time fail through an inability to put forth a propelling effort sufficient to overcome the obstacles in its path.

We will now consider the oil and gas engines, and see whether they possess advantages over steam that will enable them to overcome the most serious defects just enumerated. In so far as putting forth an extraordinary effort is concerned, they are no better off, as the torque they can develop is dependent on the pressure in the cylinder, and this cannot be increased any more above the normal, in gas or oil engines than in steam, if as much; hence, the only way by which they can meet the requirements of extraordinary cases is by the use of an engine much larger than would be required for ordinary work.

A vehicle propelled by a gas or oil engine can be operated safely by one man, and in this respect they are more desirable than steam. In the matter of weight and strength of supporting frame nothing would be gained, for the same type of mechanism is used, and the racking effect due to the unbalanced condition of the moving parts is just as great, while the additional strain caused by the explosive action of the gas in the cylinder would tend to increase the strain, and therefore call for even greater strength. So far as cleanliness goes, nothing could be gained, and, as to unpleasant odors, gas and oil engines would prove more objectionable in the end than steam. The danger of boiler explosions would be removed, but the danger of gas and gasoline explosions would, undoubtedly, fully offset this gain. The danger of fire would, if anything, be increased. The only real advantage, therefore, is that only one man would be required to run the vehicle.

The objections peculiar to most types of gas and oil engines are that they will not start unaided, and that they require an electric battery or some equivalent device to furnish the spark or flame by which the gas is exploded. Some of these engines are made self starting, and this is really the only type that would be at all suitable for vehicles; but it will have to be thoroughly demonstrated that they can start up under a heavy load, on a steep grade, before their success in this direction can be accepted without question.

In many cases the inability of gas and steam engines to put forth an extraordinary effort when required has been overcome by the use of gearing, whereby the ratio between velocity of piston and vehicle could be greatly increased, so as to increase the horizontal effort by a reduction in speed. But such an expedient serves only to increase the complication of mechanism, and, on account of the greater liability of the vehicle to get out of order, cannot be regarded as a more satisfactory way out of the difficulty than that of using a larger engine.

Great claims have been made as to the lightness of some gasoline motors; but, as they are constructed on the same general principles as

all other gas or gasoline engines, it is not apparent why they should be lighter. All engines of this class, as well as steam engines, consist of one or more cylinders with their pistons, connecting-rods, cranks, etc. As the physical properties of matter are such that they cannot be changed by the magic wand of any designer, no matter how skilful, it is difficult to believe that any one can obtain results in the way of lightness of construction that are so far beyond the reach of all others.

It is claimed for some of the gasoline engines made for automobiles that they weigh fifty or less pounds, and develop two or three horse power; however, this is not so very wonderful, because less than half this weight is claimed for a steam engine of equal capacity.

Perhaps it is possible to construct engines of this extreme lightness that will run long enough for the purposes of an exhibition test, but no engineer of repute would be willing to say that such a machine could stand the strain of constant usage.

Now let us consider what the electric motor can do in the way of removing the objections pointed out. The first point in its favor is that it cannot be stalled by any resistance, within practical limits, that may be opposed to it. A one-h. p. motor which would propel a vehicle at a speed of one thousand feet per minute against a resistance of, say, thirty-three pounds could instantly put forth an effort great enough to overcome a resistance of three or four hundred pounds, if the occasion required it. It is true that under so enormous a strain it would soon give way from being over-heated; but, in any case that is at all likely to be met in actual running, such an effort would be required only for a few seconds. Under a strain of a hundred, or a hundred and fifty, pounds, such a motor would run for several minutes, and this would be an increase of capacity simply impossible with gas or gasoline engines, without resorting to gearing. When in motion, the speed of the vehicle could be increased or reduced as desired. And all this could be accomplished by a machine that, from a mechanical standpoint, is the embodiment of simplicity. It is not only simple, but very durable, and it has but one moving part. It can be made exceedingly light without in any way impairing its strength. It is very compact, requires no attention, does not smell, will not explode, is always ready to start, and can be controlled with much greater certainty than any other form of motor known.

The only thing that stands in the way of the complete solution of this automobile problem by the electric motor is the method of obtaining the electric energy with which to operate it. The only way in which this part of the problem can be solved is by the use of storage batteries, and these devices have not given results, in the past, of such a character as to inspire confidence in their ability to meet the

requirements. But at the present time they are not so far from perfect as the great majority of electricians believe. The storage battery in its early days was the victim of sensational writers, who, according to their custom, claimed for it results that were physically impossible. Their efforts were assisted by the attempts of ill-advised inventors to compete with the trolley system, in the face of the fact that their inventions were defective in the direction in which the greatest perfection was necessary, in order to achieve anything like success in that field.

The greatest defect in storage batteries generally is inability to withstand, without undue deterioration, a rapid rate of charge and discharge, particularly the latter. If a battery cannot be discharged in less than ten hours, without over-straining, it is evident that a car or carriage would have to carry as many cells as would be required to furnish the energy used in that time; but, if the time of discharge can be reduced to one hour, the number, and therefore the weight, of cells can be reduced to one tenth.

The storage-battery field, like every other profitable line of scientific inquiry, has been invaded by charlatans, by ignorant dreamers who hoped to hit upon the right thing by luck, and by a few men who are masters of the subject. Those of the latter class have sought to obtain better results by reducing the time of charging and discharging, by reducing the deterioration, the weight, and the cost of construction either of the whole battery or of the parts that deteriorate.

The time of discharge of any battery can be reduced, but by such reduction the deterioration is very greatly increased. What is desired is to reduce the time of discharge without increasing the deterioration, and, if possible, even decrease the deterioration under such conditions. By increasing the rate of discharge, and by reducing the weight per unit of energy delivered, the total weight of battery required to propel a car or carriage can be greatly reduced. The average weight of the batteries now on the market is about one hundred and forty pounds per h.-p. hour, and the economical rate of discharge at which deterioration is not excessive is ten hours; therefore, a vehicle requiring two h. p. would have to carry 2,800 pounds of battery cells, and would be able to run for ten hours. If the battery could discharge in two hours, and weighed seventy pounds per h.-p. hour, the weight would be reduced to 280 pounds, or 560 pounds for four hours' actual running.

There are no such storage batteries on the market at the present time, but such results are within the limits of possibility, and some of the most able workers in this field have already obtained even better results. The weight of material that undergoes chemical change in a storage battery is about eleven pounds per h.-p. hour; the excess above that amount represents the weight of the cells, the supports for

the plates, the electrolytic fluid, and the unused active material. A reduction of the weight, therefore, even to thirty or thirty-five pounds per h.-p. hour, is possible, although there is not much probability of obtaining such results, at least in the near future. But the possibilities already in sight are sufficient to insure the success of the storage battery in the propulsion of vehicles.

An objection may be raised to the use of storage batteries on account of the difficulty of having them recharged, especially if they are only of sufficient capacity to run a wagon twenty or twenty-five miles. This objection would be a fatal one, as matters now stand; but, when it has been demonstrated that they can be used with perfect success in this line of work, ways will promptly be devised whereby discharged batteries may be exchanged for charged ones, at convenient places, and with but a few minutes' delay.

The general impression at present appears to be that self propelling vehicles will be used for pleasure purposes, and, therefore, that they should be able to take a run out into the country of, say, fifty miles and return. For this kind of service it is evident that electric automobiles would be useless, at least for years to come. But this is not the legitimate field for such conveyances; their sphere of usefulness will be found to be in the business world as express and parcel-delivery wagons, hacks, drays, etc.; and for this class of work electric wagons, provided with storage batteries, as light and durable as those we expect to see in actual service before long, would be successful in the highest degree.

It may be claimed that the cost of operating an electric wagon would be greater than the cost of operating one run by either gasoline or gas, and this would be true if the mere cost of energy were considered; but, if to the cost of oil or gas is added the increase in insurance charges on the vehicles and the premises in which they are housed, and also the difference in the cost of repairs to the entire outfit, it will be found that the scale will turn in favor of electricity. But the most important point in favor of electricity is that it is always ready, and able to cope with any emergency. For example, a wagon weighing, say, two tons with load would require a horizontal effort of about sixty pounds to keep it in motion on a level, well-paved street; but, if the wheels should drop into a hole in a poorly-paved street, or become stuck in deep mud, an effort of several hundred pounds would be required to extricate it. In such cases the electric motor would be found equal to the occasion, as even a two-h. p. motor would be able to put forth a momentary effort of seven or eight hundred pounds. Therefore, such a thing as stalling an electric wagon would be out of the question, and this cannot be said of any other motor.

POINTS IN THE SELECTION OF STEAM ENGINES.

By W. H. Wakeman.

A GREAT many engines are manufactured each year, and many of them, especially those of small and medium power, are purchased by men who are not judges of machinery. In purchasing an engine one of the most difficult points to settle is the size. This will surprise those who think that, if they wish to erect a mill requiring forty horse power, they need only buy a forty-horse-power engine. There are several things that should enter into the calculation, which they neglect, often because they know nothing about them. Especially is this true where engines are purchased to drive wood-working machines.

It is true that a horse power is a fixed quantity, and, as such, a perfectly satisfactory standard for reference; but there are different ways of designing an engine for a given power, and, as competition in this line of work as well as in others, is very sharp, some builders take advantage of every possible chance to give their engine a high rating, not always in the interest of the purchaser.

For illustration, suppose that two engine builders manufacture engines having cylinders of the same size, and that their catalogues call for the same rate of speed; we may yet find that one is rated much higher than the other. Three factors are used in calculating the power of an engine,—*viz.*, area of piston, speed of piston, and mean effective pressure; but, as the two first mentioned are the same in the assumed case, the latter alone becomes the variable factor. In this case the builder who rates his engine the higher may have calculated on a very high boiler pressure; or, with a somewhat lower boiler pressure, he may have based his calculation on a longer point of cut-off, which will give so high a terminal pressure that the engine cannot be called an economical one, because much of the steam passing through it is wasted. This man will frequently get the order for the new engine, as he will agree to furnish a greater power for the same price.

An engine whose piston is twenty inches in diameter, with a stroke of forty-two inches, running at seventy revolutions per minute, is a convenient size for comparison. If we take the mean effective pressure at forty pounds, then we have $\frac{314 \times 490 \times 40}{33000} = 186.5$ horse power. This mean effective pressure is calculated on a basis of eighty pounds'

gage pressure on the boilers, or ninety-five pounds' absolute pressure, and a cut-off at one-quarter stroke. The terminal pressure will then be $95 \div 4 = 23.5$ pounds, or 8.5 pounds by the gage, and it certainly should not be any higher than this for economy; some engineers would claim that it should be less than this. The point is that some engine-builders catalogue such an engine as having two hundred and fifty horse power. The mean effective pressure to develop this power can be determined by the following formula:

$$\frac{H.P.\ 33000}{A\ S} = M.\ E.\ P.$$

in which $H.\ P.$ = horse power developed, A = area of piston, S = speed in feet per minute, and $M.\ E.\ P.$ = mean effective pressure. Applying the formula, we have $\frac{250 \times 33000}{314 \times 490} = 53.6$, or, say, 54 pounds' mean effective pressure required for a development of the power named. Now, to get this mean effective pressure with eighty pounds' boiler pressure, the cut-off must be lengthened to nearly four-tenths of the stroke, making the expansion ratio 2.75 and the terminal pressure thirty-five pounds absolute, or 20 pounds by the gage, which is too high for good results. In order to cut off at one-quarter stroke, and still get a mean effective pressure of 54 pounds,—which we must have if we are to develop two hundred and fifty horse power with this engine,—the boiler pressure must be raised to one hundred pounds by the gage. If the boilers will stand this pressure, the engine may be used economically; but, where one firm of engine-builders will furnish an engine of one hundred and eighty-six horse power for a given price, and another will furnish one of two hundred and fifty horse power for the same price, to the uninitiated there seems to be a vast difference in favor of the latter. Yet on investigation we find that the cylinders are of exactly the same size, and it is quite possible that the company agreeing to furnish the greater power for the same money will even hen make the larger profit by putting in less stock, doing a cheaper grade of work, and giving the machine an inferior finish. No wrenches will come with this engine; the purchaser will have to buy a throttle valve; and it will be noted that the bottom of the frame and the outboard bearing are not planed off so as to rest solidly on the foundation, but are just as they came from the foundry. In setting the engine, it must be blocked up level and filled in with sulphur between the iron and the foundation, which is not the best method, although many engines are still so set.

Again, a steam-user desiring a new engine may write to several builders asking for prices on a two-hundred-horse-power engine, and will be surprised at the prices respectively quoted by the manufact-

urers. Further investigation shows that the party asking the higher price expects to furnish a twenty-by-forty-eight engine, running at seventy revolutions per minute,—which is not unreasonable,—while another bidder expects to furnish a sixteen-by-thirty-six engine running at one hundred and twenty-five revolutions per minute. This calls for a mean effective pressure of forty-five pounds, which, of course, can be secured ; but note the difference in speed.

I am in charge of a slow-speed engine ; wishing to be absent for half a day, I engaged to run it for me a friend who had been employed on high-speed engines. Looking at the sight-feed oil-cups on the guides and wrist-pin, he asked how long the oil in them would last, to which I replied that at night they would be something less than half full. "Where I have been employed," said he, "they would last about twenty minutes." It is true that his engines were running much faster ; but, with slight modification, this illustration will do very well here. High speed means more friction, and that means a larger expenditure of oil. It has been claimed that high speed results in economy of steam ; while this may be true when the machine is in perfect order, the increased friction soon causes leaks in the valves and piston. High speeds are not an unqualified success, and will never be universally adopted.

Let us now give some attention to the power required to run machinery. Assume, for purposes of illustration, wood-working machinery consisting of matcher, surfacer, rip saw, etc. We have been informed by their manufacturers that these machines require a certain amount of power ; but the amount stated appears surprisingly small. When we come to use these machines, we find that they take much more than the estimate calls for. Shall we claim that their builders were dishonest ? Not at all. No doubt these machines could be run with the stated amount of power, but only under the best possible conditions. The knives of the matcher and the surfacer must be sharp, the lumber clean, and the cut light. Why should it require much more power to drive them ? Because the service in the mill is much heavier. Perhaps poorly-sawed lumber must be dressed, the cut being from $\frac{1}{8}$ to $\frac{3}{4}$ inch. Such was not the sort of work for which the power-rating was made. Another load of lumber comes in that has perhaps been unsheltered from storms and is partially covered with ice. The feed-rolls slip, the boards will not feed in, and the operator puts shavings on the boards and his own weight on the feed-roll levers, and thus makes a little progress ; but the power required will be at least twenty-five per cent. greater than that needed under favorable conditions. After a time, the knives get dull ; but there are a few hundred feet more to be dressed, and after that there are some nice dry boards

to be planed, so that it is not considered good policy to grind the knives until the rough job is finished; rosin is put on the belts, and at last the work is done. If no more power is provided than is needed under favorable conditions, the engine will be running at about one-half speed, and the product of the mill will be reduced accordingly.

The same reasoning applies to a circular saw; when it is sharp and in good order, it needs but little power, but, after its teeth begin to get dull, and before it will pay to sharpen it, much more power is needed to drive it. Almost every other kind of machinery is, in a greater or less degree, subject to variable conditions,—a fact which indicates that it is always wise to have an abundance of power.

Another important thing to be considered is whether more machinery will be added, thus calling for more power than was needed at first; if this seems probable, provision should be made for it.

After this article was begun, the master mechanic of a large manufacturing establishment mentioned to the writer that, when his engine was first put in, about two years ago, indicator diagrams taken from it showed that it was developing two hundred and fifty-nine horse power, while diagrams taken within a month showed five hundred and ninety-one horse power; and still more is needed. Steam is supplied by boilers of various ages and on different conditions; and, as one of the oldest is not considered safe at the pressure required to run the engine (90 pounds), it has been cut out, and, at a lower pressure, furnishes steam for other purposes. This puts more work on those that are left; and, as more power will be needed in a short time, the old boilers are to be taken out, and new ones put in that can safely carry 125 pounds' pressure. It is not considered safe to further increase the speed of the engine. This is probably an extreme case, but it shows the necessity of anticipating and providing for increase of power. Such provision may be made by estimating the capacity of the engine with a short cut-off, and using boilers that will, with from ten to twenty pounds less than they may safely carry, deliver the power at first needed. The speed of the engine may be lower than its safe limit, and, when more power is required, the point of cut-off will be lengthened automatically. When an economical limit has been reached, the boiler pressure may be increased to the safe limit, and, when this will not supply the power needed, the speed of the engine may be increased, the main pulley taken off, and a larger one put on, so that the speed of the jack shaft will remain constant. If the engine has been run as a non-condensing engine, an independent condensing apparatus may be added,—provided water is available,—which will remove some of the useless work, and enable it to do more useful work.

In some cases it is advisable to commence with a single cylinder,

making provision for another by having the crank shaft fitted for a crank on the other end of it; when much more power is needed, the other cylinder may be added. This may be made much larger than the first cylinder, thus making a compound engine of it, or it may be made of the same size, thus making it a double engine.

In these days of high pressures and fast speeds, it is very necessary that an abundance of material should be used, in order to prevent undue springing of the parts, which, if it occur, will cause great friction, excessive wear, and frequent failures. The attention of prospective purchasers should be directed to the fact that some engines are not made strong enough for the work that they are intended to do. The frames of some of the long-stroke engines are made without central support, and so light that they spring downward in the middle at every revolution of the engine. There can be no excuse for such defects.

The crank shaft of a certain large engine in the city of New York was made so light that, when the weight of the fly-wheel was put upon it, there was a deflection of about one-eighth of an inch at the center. In consequence of such defects the weight is very unevenly distributed on the bearings, nearly the whole of it being thrown upon their inner edges, thus greatly increasing the liability of the shaft to fracture. The purchasers drove a very sharp bargain with the builders, who are located in a western city, and who finally made a price less than nearer builders; but in this, as in other cases, the purchasers got what they paid for, and nothing more. It is not good business policy to pay an exorbitant price for an engine, but it is good business policy to pay a fair price for value received. The engine in question would develop the power called for by contract, but only on a basis that permitted no allowance for variations in boiler pressure; at no time was power developed on an economical basis.

The builders of medium- and large-sized engines should be required to guarantee a certain duty for their machines, as builders of pumping engines are required to give guarantees. It is true that these guarantees would not read alike; while the pumping engine is usually guaranteed to do a certain number of foot-pounds for one hundred pounds of coal burned under the boilers, or for one thousand pounds of steam passing through the engine, the factory engine is guaranteed to develop a horse power with the consumption of a certain number of pounds of steam per hour; but this amounts to the same thing in the end. Why so little attention is given to this matter may be partially explained by the fact that in some cases the desire for getting an engine at the lowest possible first cost is the controlling motive.

Suppose that one six-hundred-horse-power engine develops a horse power with thirteen pounds of steam per hour, while another requires

fifteen. Here is a difference of but two pounds per horse power per hour, or one thousand two hundred pounds total per hour. Even if we have boilers that will evaporate ten pounds of water with one pound of coal, this means a difference of one hundred and twenty pounds of coal per hour, or one thousand two hundred pounds per day, making one hundred and eighty tons per year, which, at $3.50 per ton, amounts to $630.

Although an engine that makes good a builder's guarantee is very desirable, especially if a high duty is warranted, yet there are other things to be taken into consideration along this line; for an engine that is very economical when new may be wasteful of steam after a few years, owing to poor design or imperfect workmanship. This is a point that can be settled only by careful observation of the behavior of different types of engines after years of service. Upon this point the advice of an honest, competent consulting engineer is valuable.

It was formerly claimed by several engine-builders that the plain, flat slide-valve was superior to all others, because, as both valve and seat were flat, the longer it was run, the tighter it would get. I have not seen this statement in any catalogue for some time, and consequently believe that the theory has been exploded. When the power that moves a slide-valve is applied on a plane above the seat, the valve will wear more at the ends than in the middle, and hence become leaky and wasteful of steam. One method employed to prevent this is the use of a pressure plate to hold the valve to its seat and yet allow it to slide. It is possible to so adjust a plate that it will do this; but such an attachment requires a very close adjustment,—much too fine and close for what might be called "rough-and-tumble use." The flat valve can easily be planed off, filed, and scraped to a fit, and its seat may also be so treated; but at the same time we should not lose sight of the fact that the valve-seats of Corliss engines, and of some other types, may be bored out with a good boring bar, and the valves turned up in any lathe that is worthy of the name.

The guides are a very important part of an engine. There are three classes,—namely, the flat, the round, and the V-shaped. Flat guides are mentioned first, because they possess several points of merit. They are easy to keep oiled, because the oil does not gravitate towards any particular point. If they are made long enough to project beyond the cross-head at each end of the stroke, as they always should be, the oil will remain upon them at these points, and, as the engine revolves, the cross-head will come in contact with this oil and draw it back upon the guides, as may be easily noted, especially in the case of a slow-speed engine, where all of the movements may be followed by the eye. Where this form is adopted, the cross-

head may be brought into line with the cylinder easily and accurately, and any departure from truth may be detected at once and remedied. In order to do this, the guides should be made in separate pieces, and bolted on the frame, so that they may be taken off and planed smooth, when worn or scored. When made in this way, the cross-head may be made of iron also, or of iron lined with brass, thus insuring great durability; and, if the iron cross-head ever does run dry and score the guides, it is an easy matter to repair the damage. The durability thus secured more than offsets the liability to abrasion.

In the case of guides that are bored out in line with the cylinder, there is less liability that the cross-head will bind on the guides through imperfect alignment of other parts; but, at the same time, the guides can be more easily thrown out of their proper course than any other kind or form. Where the cross-head is made wholly of cast-iron, and runs on cast-iron guides bored out, both parts will last for many years without excessive wear, provided they are always well lubricated. I have seen guides of this type that had been in use for two years, on which the tool-marks were still visible, showing that the wear was unworthy of mention; but, if such guides are ever allowed to become partially dry, they commence to cut without warning, and the whole surface is ruined at short notice. One trouble with them is that the oil put on them gravitates toward the lowest point and tends to leave the high parts without lubrication.

The V-shaped guides hold a cross-head rigidly in place,—a fact which is almost their only recommendation. As frequently made for Corliss engines, these guides are cast in one piece with the frame, and the cross-head shoes are lined with Babbitt metal; consequently the guides are seldom found to be cut or scored, for the Babbitt metal will melt out, if neglected too long. The redeeming quality with this arrangement is that the Babbitt metal may be easily replaced. As a rule, the upper and lower cross-head shoes are interchangeable, so that, with an engine running "over" when the lower one is damaged or worn out, the upper one may be put in its place for a time. This form of guide needs more lubrication than any other kind, for all oil placed on the upper part of the V rapidly finds its way to the bottom, leaving the higher parts dry.

There are two general plans for putting a wrist-pin into the cross-head; one is to cast it in, thus making it solid with the cross-head, and the other is to bore a hole through the cross-head, turn up the pin, and drive it in. In the former case, after the engine has been run for several years and the pin is worn out of round, it is a difficult matter to repair it, without special machinery. In the latter case, the pin may, in a lathe, be made as round as it ever was. The objection

to this arrangement is that sooner or later wrist-pin boxes will be accidentally keyed up tighter than they should be, with the result that the pin, being in a round hole, is loosened in the cross-head. No wrist-pin should be accepted, unless it is either cast in, or solidly keyed into, the cross-head at both ends of the pin.

If a piston rod were always perfectly in line, and would never wear out of truth, it would be a much more simple matter to provide stuffing box packing. Under existing conditions we must have packing of various kinds to suit different cases. The use of fibrous packing concerns the economical operation of a plant more than it does the selection of the engine; but, in passing, it may be said that metallic packing is preferable. It may seem rather expensive at first, but it pays in the end by saving in the cost of soft packing, and by obviating unnecessary wear. For an engine of which I once had charge, which was fitted with metallic packing for the rod, an arbor was turned the exact size of the rod, and the packing nicely fitted to it. After the rod had been in use for nearly five years, a comparison of its size with that of the arbor showed that the rod was smaller than the arbor, but not more than $\frac{1}{100}$ inch. Metallic piston-rod packing is a paying investment, and it is wise to specify it when the engine is ordered. Every engine should have a properly-designed and well-built fly-wheel. When fly-wheels burst, they are capable of doing great damage to life, limb, and property. A fly-wheel should have metal enough in the rim not only to make it stiff enough for every-day use, but also to prevent it from springing outward between the arms, for it has been demonstrated that this action does take place at high velocities. The distance between the arms at the rim should not be excessive. No inflexible rules covering every set of conditions can be given, but one point must not be overlooked,—namely, the speed of the rim; this should never exceed 4,800 feet per minute, or 80 feet per second, for any form of cast-iron wheel. Although some wheels exceed this safe limit, it is better to be on the safe side. If the governor fails to work properly for a few seconds only, the safe limit of speed is soon passed. Every engine should have a stop motion of some kind on it, so that, if the governor-belt breaks or runs off from its pulleys, the engine cannot run away. The too-frequent fly-wheel failures have also demonstrated that provision for automatically shutting off steam when regular speed is exceeded and the governor-belt is in place should be supplied. I have thus presented the principal points to be considered by those who contemplate purchasing engines, and which practice and observation have shown to be essential to satisfactory results. Their observance will aid in preventing unprofitable investments and subsequent annoyance.

MODERN MACHINE-SHOP ECONOMICS.

By Horace L. Arnold.

II.—PRIME REQUISITES OF SHOP CONSTRUCTION.

THE space given to the following consideration of machine-shop construction not permitting detail, it will be devoted to a limited survey of good or late practice with a view to determining the general form and arrangement of shop-buildings in which work can be most cheaply built,—that is, in which work can be built with the least expenditure of effort on the part of managers, superintendents, foremen, and workmen.

The requirements of a machine-shop building are sufficient floor-area, protection from the weather, abundant and uniform lighting, and such general arrangement and appliances as shall involve the least transportation of work in progress and effect necessary handling in the cheapest manner. The following are the essentials.

For the workmen, ventilation, sanitation, avoidance of unproductive travel and of floor spaces not at all times open to observation, and an individual space wholly under control of the workman, where he can store his street clothes and other personal effects; intimately connected with this individual space there should be also individual wash-basins, although the most advanced American machine shop so far observed furnishes in a general wash-room one basin for two workmen. The Brown & Sharpe vise bench leg provides for individual wash-buckets for workmen, which is in many ways an excellent arrangement, but the washing arrangements and clothes lockers should unquestionably be close together, and should not be on the shop floor, because of the labor and annoyance caused by filling and emptying wash-buckets, and the want of room on the work-floor for workmen's clothes closets or lockers.

For the officials, there should be a separate space in each department, and for many of the officers a separate room for each individual; all of the offices should be connected by the shortest line of travel, which should not pass through any individual or departmental territory. Most men intent on one pursuit or problem are at their best in solitude, and this solitude should not be broken except when the individual's attention is demanded,—certainly not by the passage through individual territory of those seeking some other objective point. After the possibility of official segregation, or solitude, comes the very important possibility of speedy personal official communication with any place or individual in the establishment, and personal official observa-

tion of any department of the works. The rule of solitude for master is reversed for man, unless some system can be devised to make each workman as wholly earnest in his labor as is his superior. In all cases of day-wage every man should be constantly under the eye of many others, and should be perfectly aware that every act of his working hours may be seen by his paymaster. Hence every part of the work-floors of the shop should be exposed to view from the office-floor with the least possible official travel. None of these conditions can be secured with the many-floored shop structure in any form of parallelogram, and late shop structures show a steady departure from this form of machine-shop building.

Colt's Armory, of Hartford, Conn., which was finished in 1855, forty-one years ago, is one of the best examples of a multi-floored machine shop. This building is in the H-form, five hundred feet long in each member, and having wings extending from the H-cross-bar; the front has four floors, the rear and cross-bar have three floors, and the side wings have, I think, one, two, and three floors. The business offices are in a detached building shown at the left of the engraving, connected to the north end of the front main building by a covered way, and the foremen's offices are in the "towers" or projecting structures in the middle of the main buildings. The floors are, I think, eighty feet wide, and are as well lighted as is possible from the sides only. Colt's Armory exerted a great influence on American shop construction; it was undoubtedly the best of its period; it is of such form that only a part needed to be built at first, as more could be added when demanded; in the dimensions adopted it gave more floor-room than a hollow square form on the same ground area, was equally well lighted, had shorter lines of work-travel and official travel, and gave detached work-rooms, which have, until lately, been generally regarded as desirable, or even indispensable, features of industrial architecture. At the present time, however, both the working need for the separate-room feature of the machine shop and its economy are denied. In late light manufacturing examples the separate room has been wholly avoided, except for japanning,—electro-plating, brazing, and polishing and grinding being placed on the same open floor with all the ordinary light machine tools and vise work. Japanning demands an enclosure by itself, because of dust, and because of its ovens, but chiefly because the dust of any workshop would be fatal to the lustre of finished "enamelling," as japanning is now termed by the bicycle makers,—although enamelling on metal is a well-known art wholly distinct from the japanning in which most cycle framework is finished. The foundry should also be kept in a building or enclosure by itself, although it is not separated

wholly from machine-tool floors in the Lane & Bodley shops of Cincinnati. A vast majority of machine-shop superintendents would, however, insist that the foundry, and its close adjunct, the castings-cleaning and pickling room, should be in separate enclosures, and the smithy is also thought to be better placed in a separate structure. In many of the cycle factories, which are at present our most advanced light machine shops, brazing is put in a detached building ; in other factories brazing fires appear in close connection with machine tools without the slightest inconvenience. Speaking generally, it is undoubtedly correct to put the foundry, the rattlers and pickle tubs, and the hammers in separate rooms. The drawing room must also be in a separate enclosure, and should never be, though it often is, a part of a thoroughfare from the office to the shops, or from one portion of the works to another. The old machine-shop practice commonly divided the floor space into many apartments, separated by close partitions: now the best shops have but three shop enclosures,—the foundry, the smithy, and the machine shop. The great economy of the full open floor is as well understood now as it was in the busy days of Colt's Armory, when many of the five-hundred-feet floors were open from end to end without obstruction. A very decided converse to the open shop floor practice has existed, and still exists, in the Pratt & Whitney, Brown & Sharpe, General Electric, and many other large shops ; others again, fully as large as, or even larger than, those mentioned, use one vast floor, every foot of which is open to the simultaneous observation of one man.

Unquestionably the open floor is in every way to be preferred to the separate-room plan for operations which do not interfere with each other. Separate rooms entail a vast amount of needless labor and lost time, even when workmen do their best ; where workmen are not more than commonly honest and earnest in their toil, they fall before the temptation of convenient obscurities, and drop into easy habits of chatting and loitering in spots where the eye of the foreman is not likely to reach them. Separate rooms also waste a very large floor space and intercept light, which is always insufficient in side-lighted rooms, and, taken all in all, perhaps no mistake in shop design is productive of more evil results than that of placing each department or subdivision of work in a separate enclosure. Emphatically the separate rooms in any work shop should be as few as possible. The drawing room, pattern shop, and model room or experimental construction room, are all closely allied departments, and should all be above the first floor, because of dust, and should all be of easy access from the offices. The model or experimental room is often made a part of the tool-making department ; it is often locked up away from everything

else, as it unquestionably should be. The development of a new idea is best carried out in secret. For many reasons the offices of the machine shop should be on the second floor. The second floor is, in almost all cases, cleaner, better ventilated, and in every way a more desirable location than the first floor. If the ease of the visitor is to be studiously considered, an elevator can be used. One flight of easy stairs is not a serious objection to the second-floor business office, and a second-floor office is above the dust of the street, which by itself is advantage enough to warrant an elevated location.

None of the early shops were supplied with the traveling crane, now regarded as absolutely indispensable. In Colt's Armory the work was so light as to render cranes needless; the heavy New England shops, like the Birmingham Iron Foundry, the Farrel foundries at Waterbury and Ansonia, the Woodruff & Beach works at Hartford, and the Builders' Iron foundry at Providence, were scantily supplied with jib cranes; the South Boston Iron Works had one large lathe built for the United States government for heavy gun construction, served with a small traveling crane; both lathe and crane are now at Watervliet Arsenal, West Troy, N. Y., the lathe being much nearer modern lines than the crane. The use of a jib crane which could place a heavy piece on a trolley, and another jib crane to take the piece off the trolley, was the accepted practice until recently; up to the time of the electric crane there was no perfectly satisfactory traveling crane; Sellers had done possibly the best that ever was done with the shaft-driven traveling crane; the air-driven traveling crane has the dragging air hose, and the rope-driven cranes are comparatively slow in action. The light air-hoist traveling crane, now so common in good foundry equipments, is not many years old in America, and it is safe to say that up to 1890 the advantages of the traveling crane and the air hoist were not generally understood by our machine-shop managers. The advent of the electric-driven traveling crane revolutionized shop construction for heavy work; the use of this admirable application of electric power transmission effected such savings in handling work as to force its installation in every new shop, and a shop floor full of machine tools and covered by a traveling crane overhead demands a building and method of power transmission for tool driving not known in this or any other country until late years. For all shops handling pieces of as little as five hundred pounds' weight even, the traveling crane is needed, and, where the work reaches into ordinary steam-engine proportions, this agent is indispensable.

The Walker Manufacturing Company's shops, Cleveland, Ohio, are said to be among the first, if not the very first, of American machine shops fully equipped with traveling cranes; at the present time

no shop intended for heavy work would be built without the installation of traveling cranes wherever they could be made useful, and the type of shop cross section shown in the Walker, Niles, and Laidlaw-Dunn Gordon shops lends itself so readily to traveling-crane requirements that it has come to be regarded as settled practice.

Space does not permit any extended consideration of the important points of machine-shop design affected by power transmission and crane support. Present practice warrants the prediction of electric driving, probably with a continual decrease in the use of leather belting, down to the minimum of a single belt for driving individual tools; possibly the present favorite practice of electric-driven short-line shafts may become the standard; cranes will be altogether electric driven, and the air hoist will be largely used.

This paper is written in the full belief that the form of machine-shop buildings has a very great influence on the labor cost of machine work.

It may seem impossible to the experienced machine constructor that really good and really well-equipped and well-managed shops can be handicapped by the mere shape of buildings to the extent of ten per cent. in the total labor cost of production; yet the writer is convinced, by a very extended observation of the machine shops of the United States, that a difference of labor effect amounting easily to one hour in every ten hours of labor time can be gained by the use of the best form of shop structure.

Endeavoring to support and maintain the proposition that great economic gains may be made by the adoption of the best general conception of machine-shop design, and also to show from American shop construction practice what this best form of machine shop is, nearly thirty pages of illustrations of notable American machine shops, small and large, old and new, accompany this text, with caption lines indicating the essential features of each.

It is believed that machine-shop construction variations tend steadily towards one certain well-defined form of shop plan, and that this ultimate ground-plan can be perfectly supplemented by either wood or brick walls roofed in either of two forms; one, the ordinary ventilated gable roof, of which the Sterling Cycle shops and others are examples; the other, the saw-tooth roof, shown in the Straight-Line and De La Val shops. Of these last two shops only one is homogeneous so far as the workshop roof is concerned, while no instance is known in which the entire assemblage of stores, offices, and workshop is either walled or roofed in the same manner. In the new Westinghouse shops at Pittsburg the very large principal structure is homogeneous throughout, a design having been found which housed workshop-

offices and shops in structures of the same outward form, by a variation in flooring. Speaking strictly, there is at present no machine shop and offices building in the United States which is homogeneous throughout, and the De La Val is the only one in which the machine shop is in all its parts an assemblage of simi'ar units.

Inspection of the Westinghouse shops was permitted, but illustration was denied, which is to be regretted, as the design is in the line of advance which has been assumed, although not an entire departure from the separate-building practice, and by its magnitude shows – as is shown on a smaller scale by the Sellers, Niles, Tweedvale, Gates Iron Works, De La Val, and Sterling Cycle Factory—that it is not only possible, but in every way convenient and desirable, to put an extremely large machine-shop plant on a single open floor without partitions. The Tweedvale shops have not been personally inspected by the writer, but are believed to be in the line of open main-floor construction. In the Westinghouse, the machine-shop floor is the full size of the main structure ground plan, and unobstructed. This shop does work of all weights from the heaviest to the very lightest, and the transmission from the power house to the shops is wholly electric. The Brown & Sharpe new No. 1 building extension, upon which great thought and expense were bestowed, makes no use of electric driving; the power transmission is with flat leather belting. The Monarch Cycle Shop's new building, Chicago, has a rope drive for its main lines of shafting. The Baldwin shops are using a mixed system of power transmission, tending toward a uniform practice of placing the dynamo between the engine and the shafting. It is probable that the rope drive is more economical than the flat leather belt, and that electric transmission is the best of the three systems. No case is known where the change has been made from electric back to belt transmission. Electric-driving power transmission carries power to any desired point at extremely small cost, and permits the use of small motor units, so that, except for machine-tool cone belts, leather belting need not be a transmission element. There is but one possible rival to electric transmission of power. Gas can be carried in pipes even more cheaply than an electric current can be carried by a conductor, and, if the heat and noise of the gas engine can be eliminated or in any manner made unobjectionable, then the gas engine in small units will perhaps supplant the dynamo and electric motor. Let this be as it may, the machine shop constructor is no longer hampered by the necessity of carefully-considered means for distributing power; he can lead his power wherever he can run a wire, and a motor, at a cost of $50 or $60, will drive any ordinary machine tool.

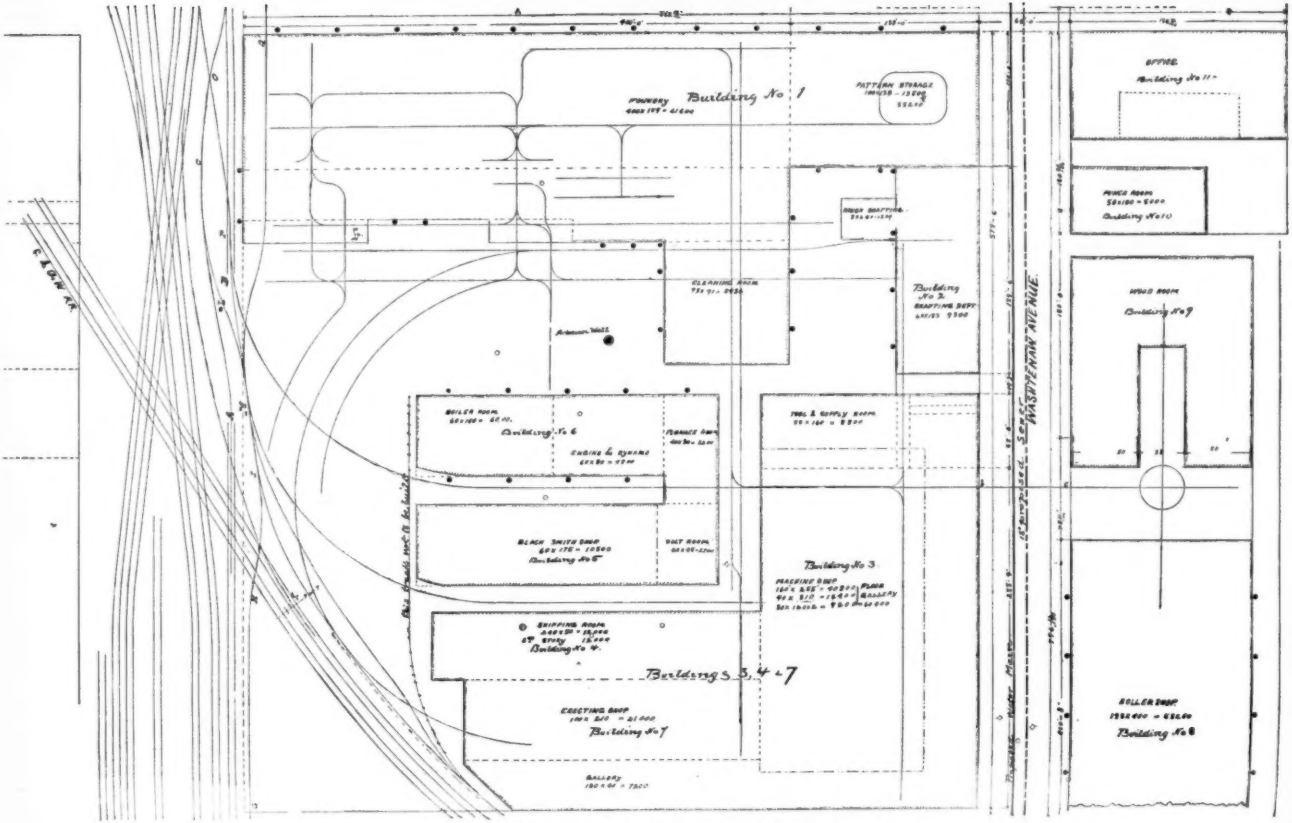
In view of the examples shown, there would seem to be no ques-

tion as the best form of the machine-shop floor: it should be a rectangle, the more nearly square the better, all wide open. The floor, in the Gates Iron Works example, is supported by the earth directly; in the De La Val shops the floor has an open air space under it. The walls, except in shops of very small extent, will not carry the roof, which will be supported by metal columns, like the traveling cranes. The practice of heating by the blower system, may be said to be well established. The foundations for such a structure have very small loads to sustain.

Hence it is clear that, if the single open floor be adopted as the desirable workshop condition, a very cheap construction may be used. The Mackintosh & Seymour shops are said by the owners to cost $0.50 per square foot of floor surface. The De La Val shops, of wood, with elevated floor and air space underneath, cost about $0.75 per square foot. Brown & Sharpe write that the foundations of their buildings are unusually substantial and expensive, and that the buildings are fire-proof, and were built partly by contract and partly by day work, and that, with cheaper foundations, they might have been erected for $2.50 per square foot of floor surface. The De La Val concern believes it could not suffer much loss by fire (although the shop is a wooden structure), because there is so very little of the walls, and that little is so widely distributed. The Gates Iron Works could suffer the loss of its offices, and so could the Mackintosh & Seymour shops, the Sellers, the Walker Manufacturing Company, Laidlaw-Dunn-Gordon, the Straight Line Engine shops, and any of the single-floor single-room structures; none of these places could have their machine tools much hurt by fire, and such a building as the Mackintosh & Seymour Shops stands in very small danger of burning. Generally speaking, the danger of fire increases rapidly with increase of superimposed floors, and the multi-floored shop structure is a constant menace through fire liability, unless built fire-proof at great expense.

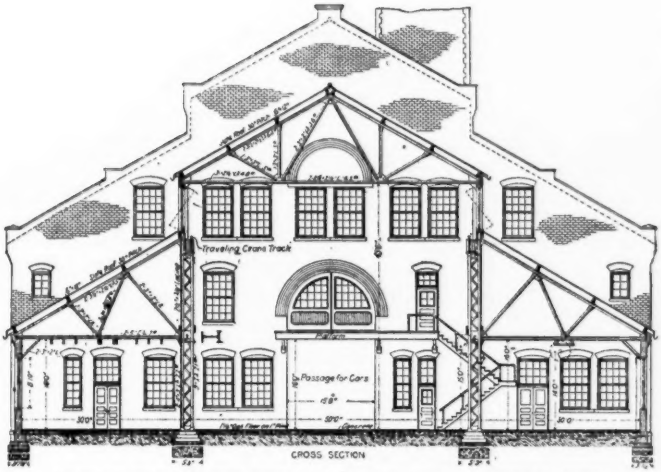
It is very important that a machine shop should be capable of extension as business increases, that the workshops and offices should have the best relative arrangement, and that both shops and offices should be lighted in the best possible manner. In a succeeding article I shall show a composite machine-shop design, embodying only features selected from examples of actual construction here illustrated. A shop built after such a design would be capable of extensions as business increased, would be always perfectly lighted in any environment, and would embody the best known offices and shop arrangement.

(*To be continued.*)



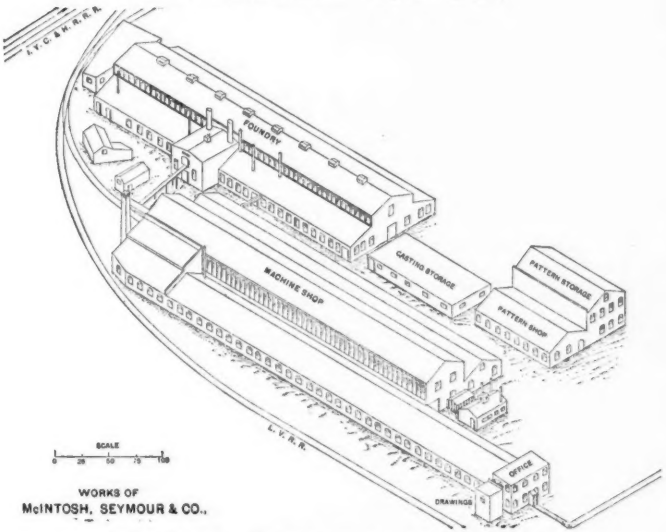
FRASER & CHALMERS NEW SHOPS, CHICAGO.

Foundry built, other works in progress; separate buildings of superior design and great magnitude; multi-floored where work permits; design influenced by considerations which govern the general electric plants, Brown & Sharpe, Baldwin & Lozier Cycle Co.



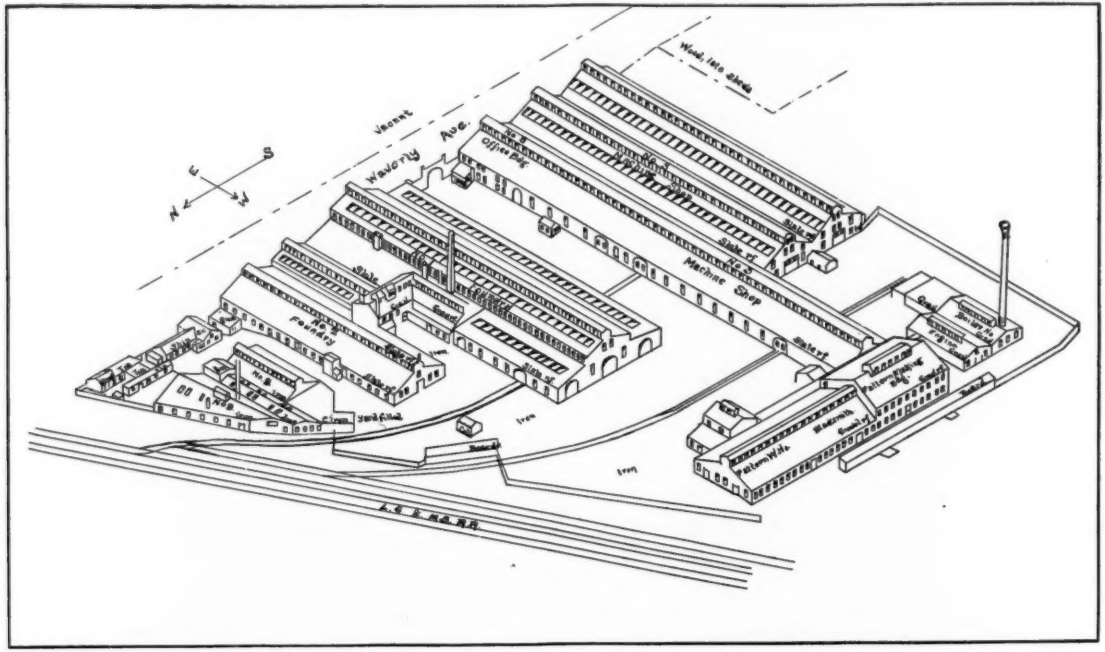
LAIDLAW-DUNN-GORDON TWEEDVALE SHOPS, NEAR CINCINNATI, OHIO.

Single floor, open structure. For plan see page 276.



THE MCINTOSH & SEYMOUR ENGINE SHOPS, AUBURN, N. Y.

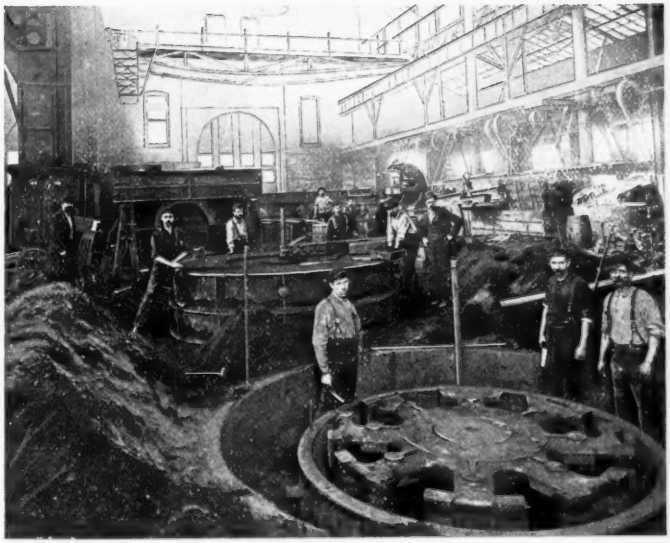
These are small single-floored open shops, extremely well lighted, and very favorable examples of a good low-cost construction of side-lighted shops.



WALKER MFG. CO , CLEVELAND, OHIO.

Generally rectangular form with close grouping of similar structures, single floors, traveling cranes, and unobstructed areas of observation.

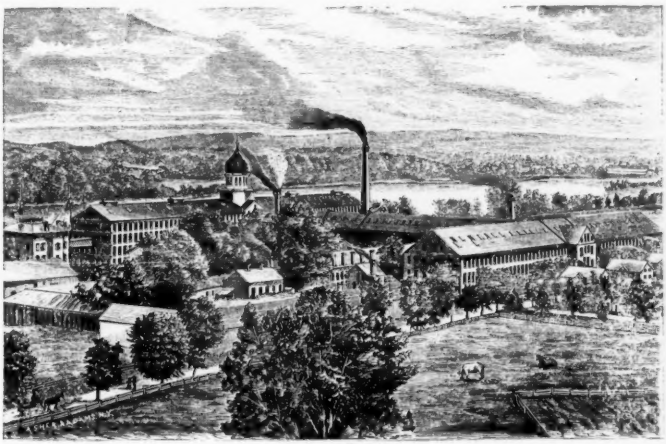
WALKER MFG. CO., CLEVELAND, OHIO.



FOUNDRY INTERIOR, WALKER MFG. CO.

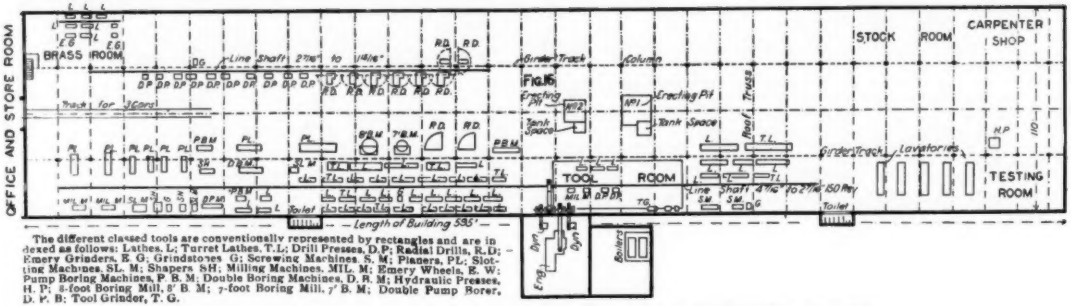
DYNAMO FLOOR, WALKER MFG. CO.

COLT'S ARMORY, HARTFORD, CONN., VIEW FROM N. E.



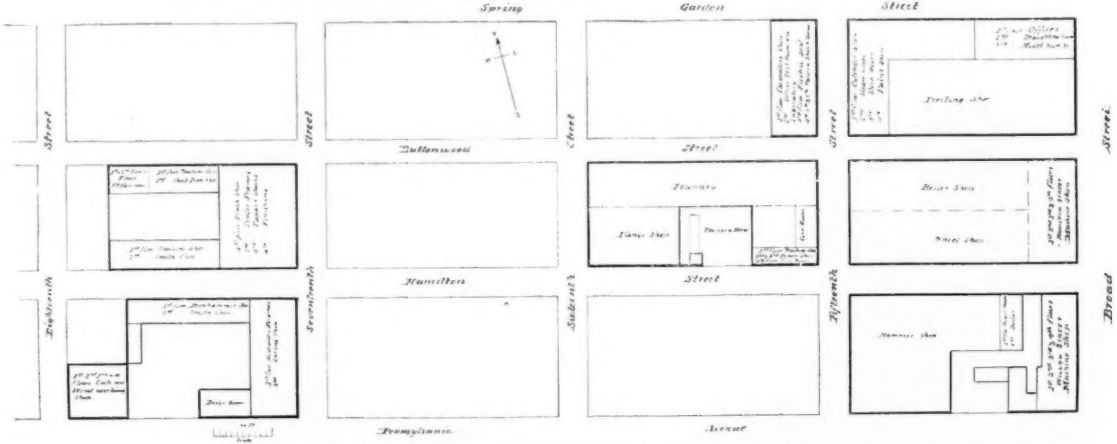
VIEW OF COLT'S ARMORY.

At the time of its completion, 1855, this was among the best manufacturing machine shop buildings in existence, and was long regarded as a model establishment. Its marked features were, H-ground plan, each member 500 feet long, multi-floored, brick; subsequently increased by wings extended from the H cross-bar. View from N. W.



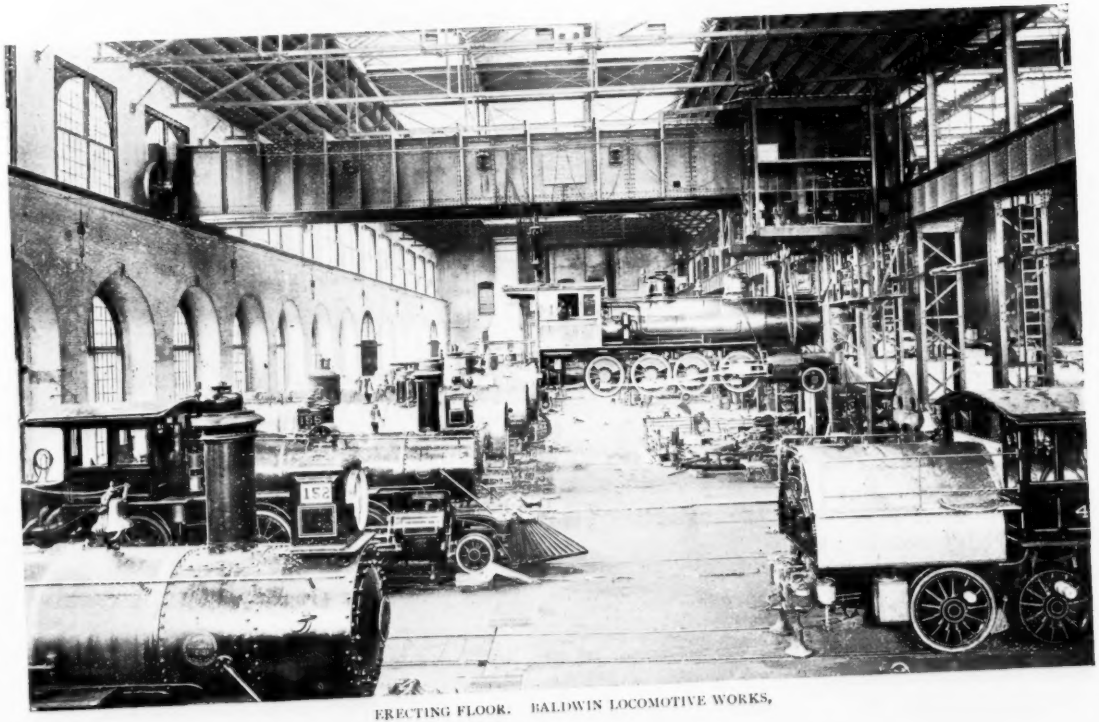
The different classed tools are conventionally represented by rectangles and are indexed as follows: Lathes, L; Turret Lathes, T.L; Drill Presses, D.P; Radial Drills, R.D; Emery Grinders, E. G, Grindstones G; Screwing Machines, S. M; Planers, PL; Slotting Machines, SL. M; Shapers SH; Milling Machines, MIL. M; Emery Wheels, E. W; Pump Boring Machines, P. B. M; Double Boring Machines, D. B. M; Hydraulic Presses, H. P; 8-foot Boring Mill, 8' B. M; 7-foot Boring Mill, 7' B. M; Double Pump Borer, D. P. B; Tool Grinder, T. G.

PLAN OF LAIDLAW-DUNN-GORDON SHOPS, TWEEDVALE, OHIO. FOR ELEVATION SEE PAGE 271.



PLAN OF BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA, PA.

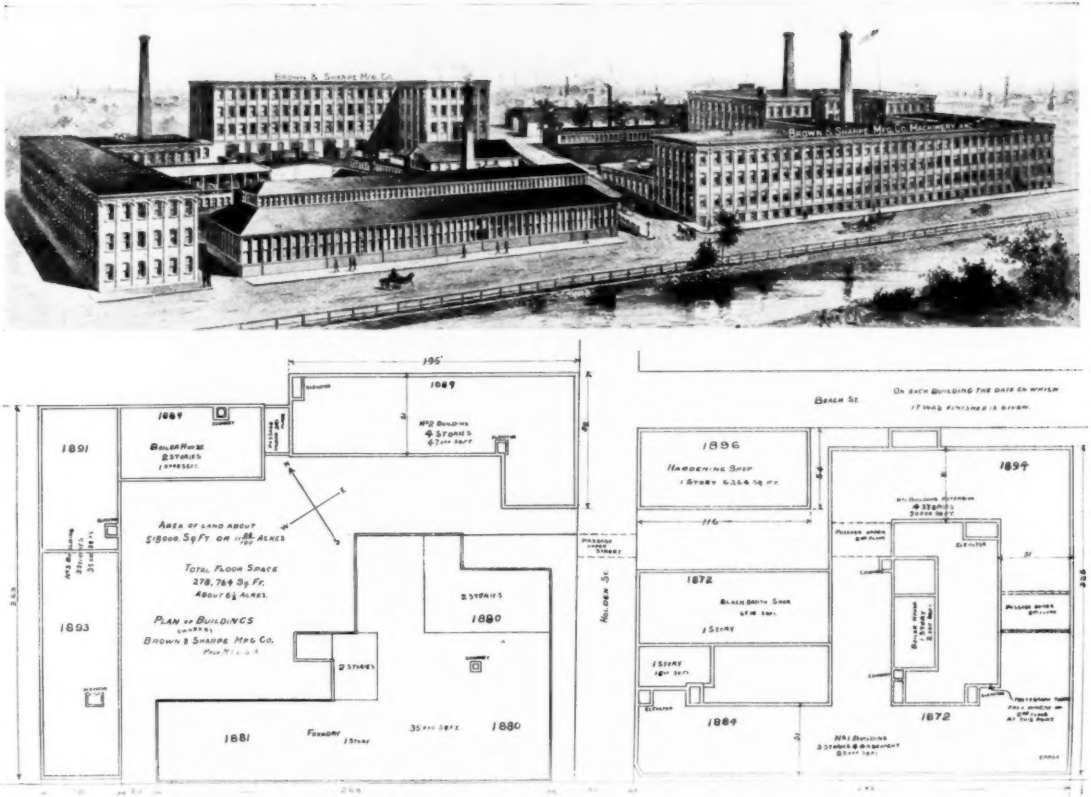
Extensive buildings, multifloored where more than one floor is possible, within the past few years supplied with traveling cranes and electric driving extensively introduced.



ERECTING FLOOR. BALDWIN LOCOMOTIVE WORKS.

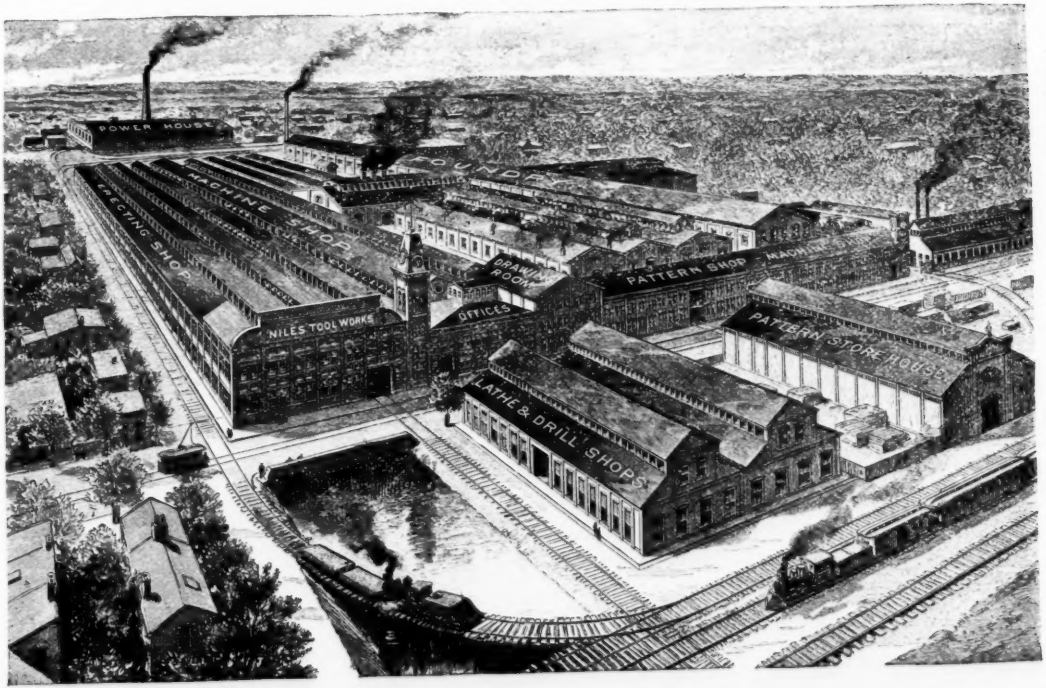
FOUNDRY, BALDWIN LOCOMOTIVE WORKS ; JIB CRANES TO SERVE THE FLOOR AND SMALL ELECTRIC CRANES ON EACH SIDE OF JIB CRANES TO CLEAR THE FLOOR

ELECTRICALLY DRIVEN WHEEL LATHES, BALDWIN LOCOMOTIVE WORKS.



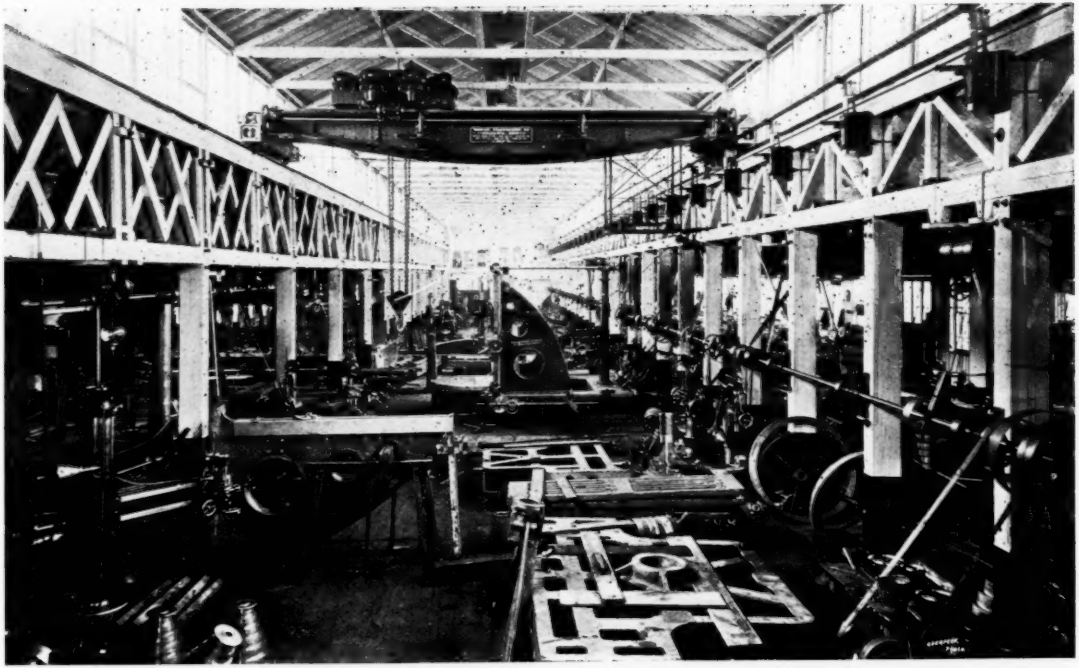
BROWN & SHARPE SHOPS, PROVIDENCE, R. I.

Separate buildings, multi-floored, perhaps the very best that can be done with this type of shop structure; advanced in detail.



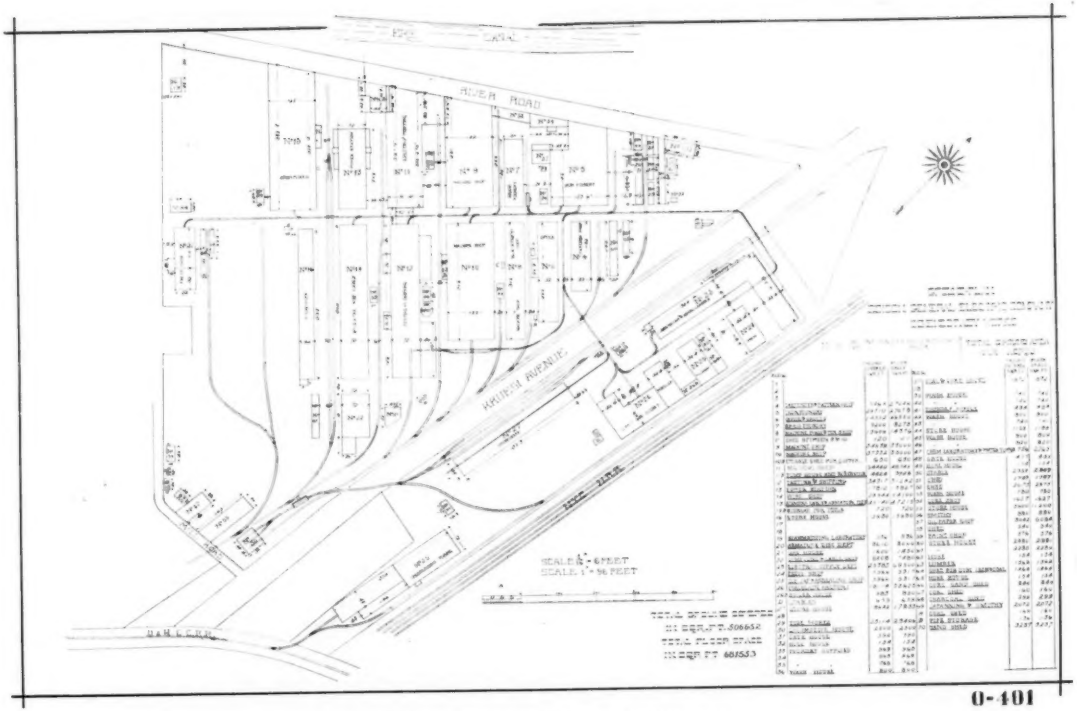
NILES TOOL WORKS, HAMILTON, OHIO.

Single floor, rectangular plan, close grouping, unobstructed view, traveling cranes; design dominated by the same general motives as the Sellers, Walker, Straight Line Engine, De La Val, Sterling Cycle, Gates Iron Works, and Tweedvale shops of Laidlaw Dunn-Gordon Company.



ERECTING FLOOR, NILES TOOL WORKS, HAMILTON, OHIO. FOR BIRD'S EYE VIEW SEE PAGE 281.

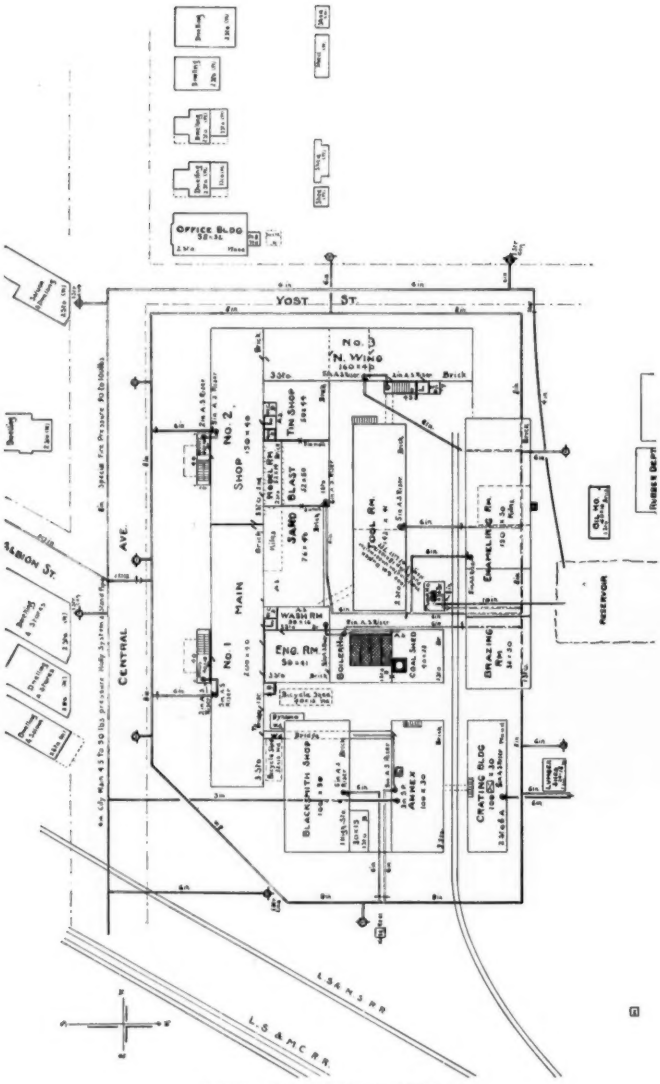
NEW FOUNDRY INTERIOR, NILES TOOL WORKS.



GENERAL ELECTRIC SHOPS, SCHENECTADY, N. Y.

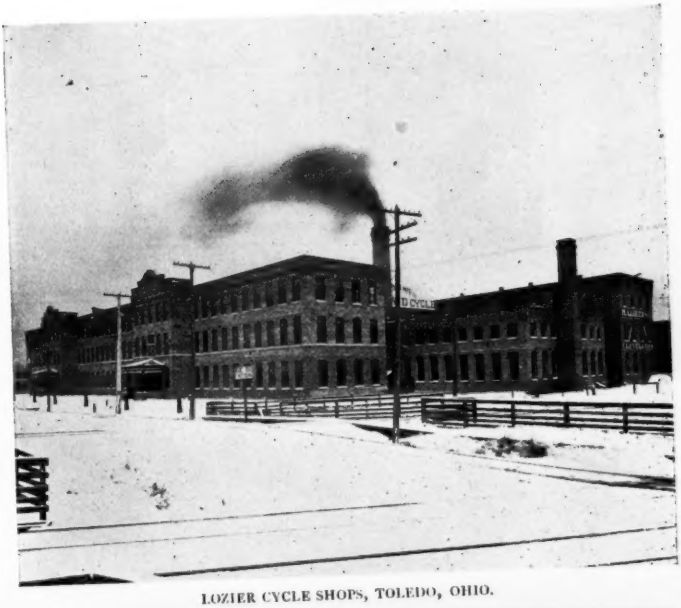
Separate buildings, multi-floored where the weight of work permits; largely electrically driven.

GENERAL ELECTRIC SHOPS, SCHENECTADY, N. Y.

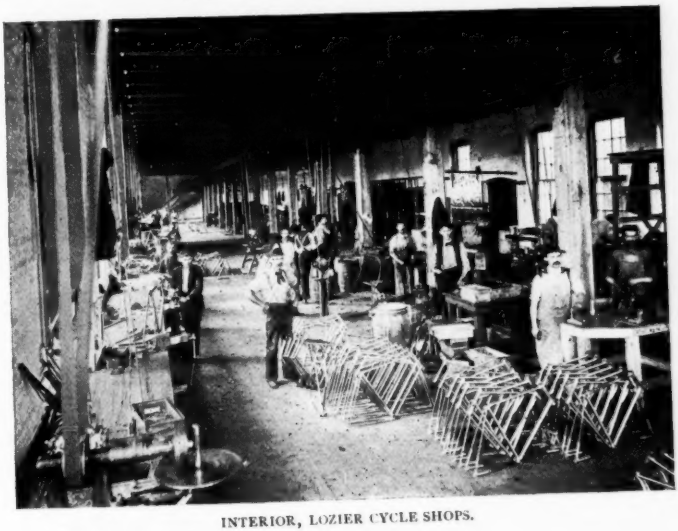


LOZIER CYCLE SHOPS, TOLEDO, O.

Separate buildings, multi-floored where work permits, 1894–5.

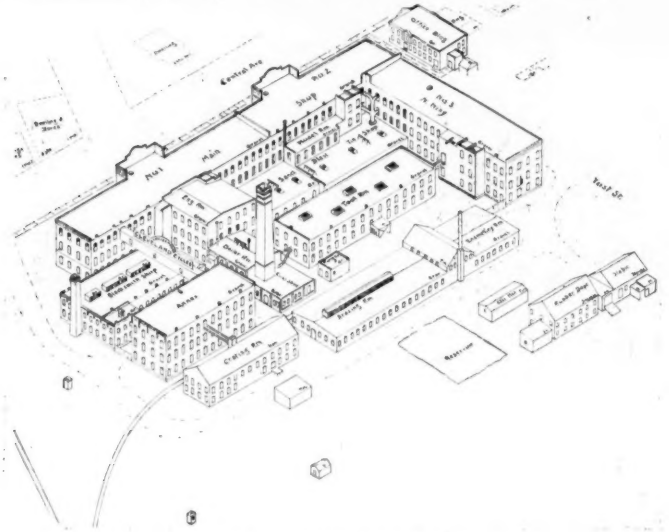


LOZIER CYCLE SHOPS, TOLEDO, OHIO.

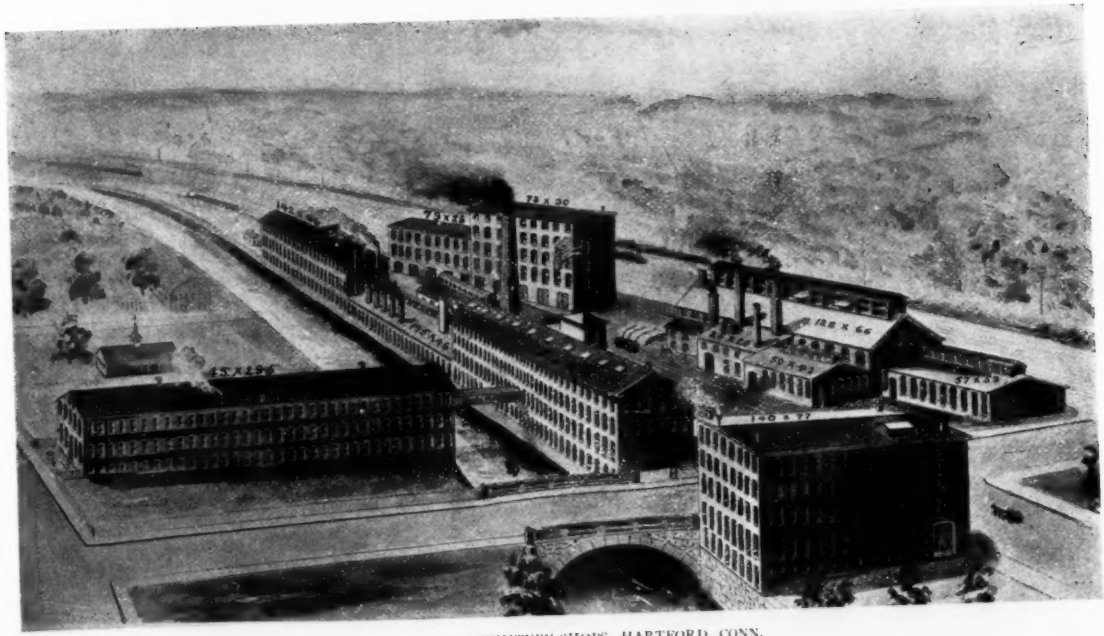


INTERIOR, LOZIER CYCLE SHOPS.

STERLING CYCLE SHOPS, KENOSHA, WISCONSIN. FOR PLAN, SEE PAGE 298.

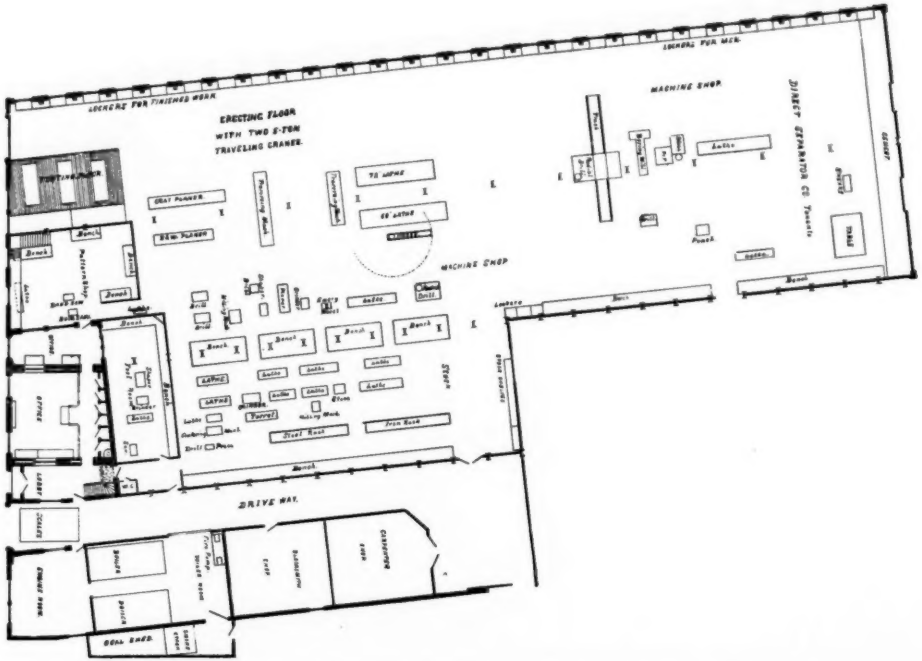


LOZIER CYCLE SHOPS, TOLEDO, OHIO.



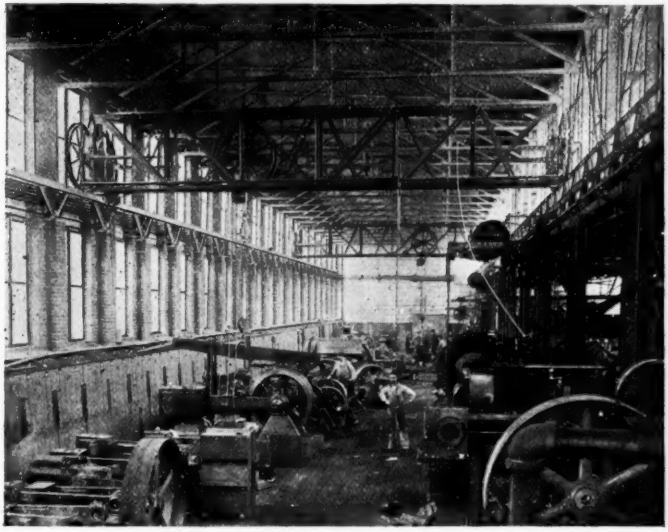
THE PRATT & WHITNEY SHOPS, HARTFORD, CONN.

Separate buildings, increased from time to time from small beginnings.



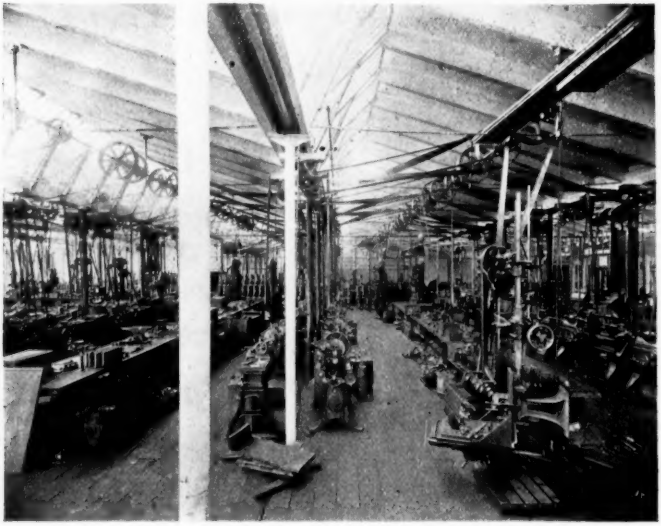
SWEET'S STRAIGHT LINE ENGINE SHOPS, SYRACUSE, N. Y. SINGLE FLOOR, SAW-TOOTH ROOF.

INTERIOR, STRAIGHT LINE ENGINE SHOPS. LIGHT FROM SAW-TOOTH ROOF.

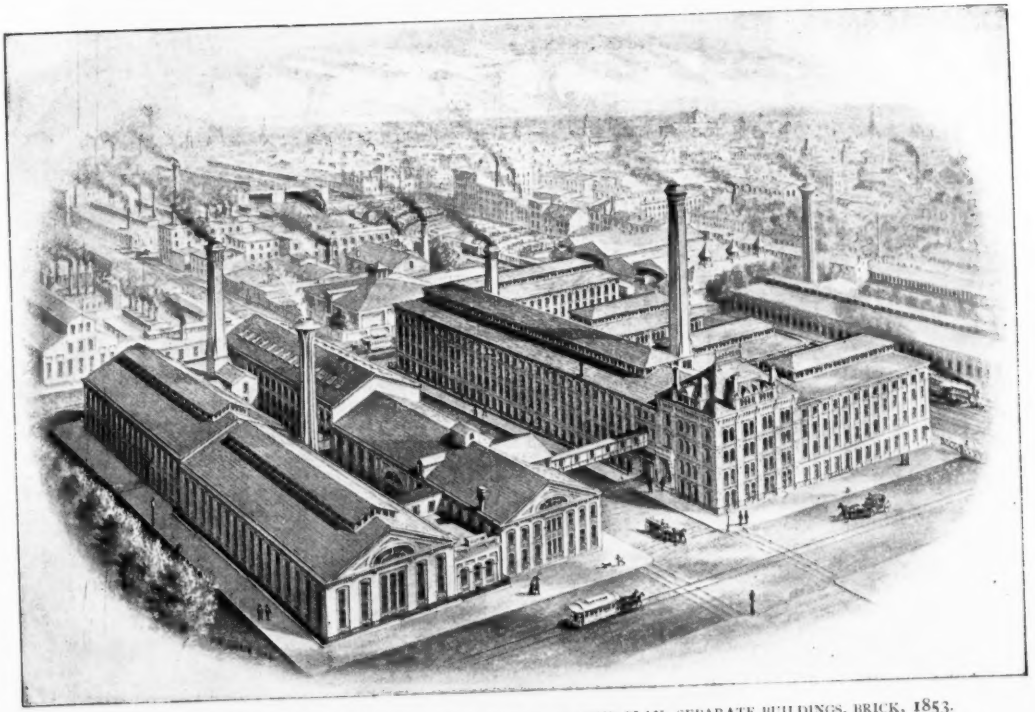


ERECTING FLOOR, STRAIGHT LINE ENGINE SHOPS.

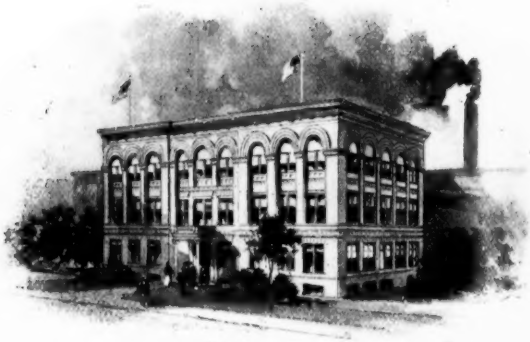
DE LA VAL SHOPS, POUGHKEEPSIE, N. Y. SINGLE, OPEN-FLOOR, SAW-TOOTH ROOF.

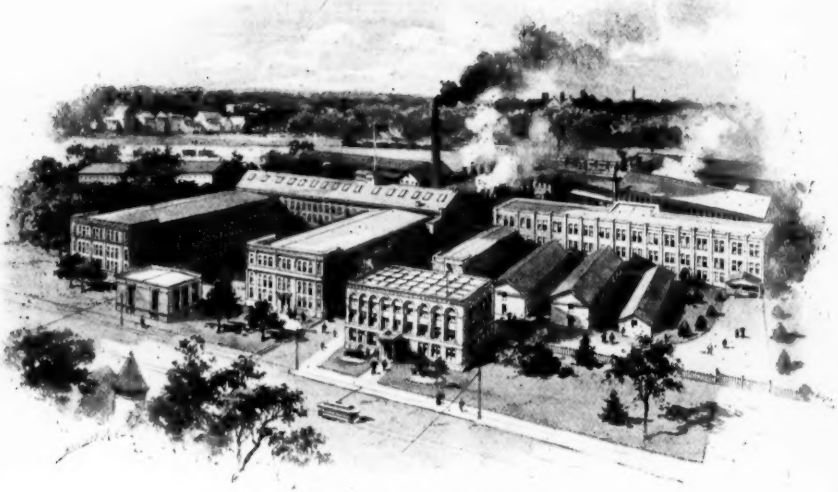


INTERIOR, DE LA VAL SHOPS.



WM. SELLERS & CO., PHILADELPHIA, PA. RECTANGULAR GROUND PLAN, SEPARATE BUILDINGS, BRICK, 1853.





COLUMBIA CYCLE FACTORY—HARTFORD, CONN.

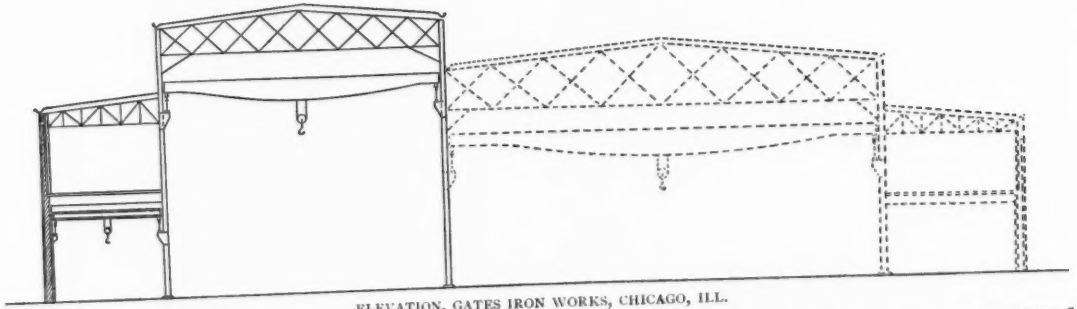
Separate multi-floored brick buildings, built at different times. Multi-floored office building in front.

GATES IRON WORKS, CHICAGO, ILL.

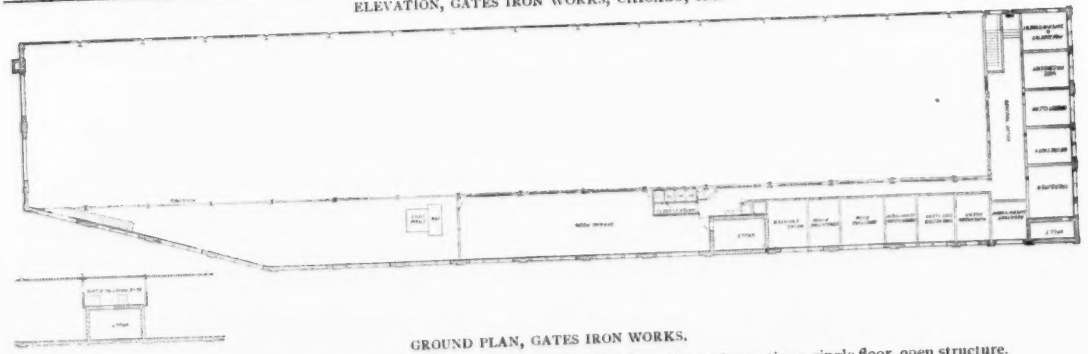
GATES IRON WORKS.

DRAFTING ROOM, GATES IRON WORKS.

INTERIOR, GATES IRON WORKS.

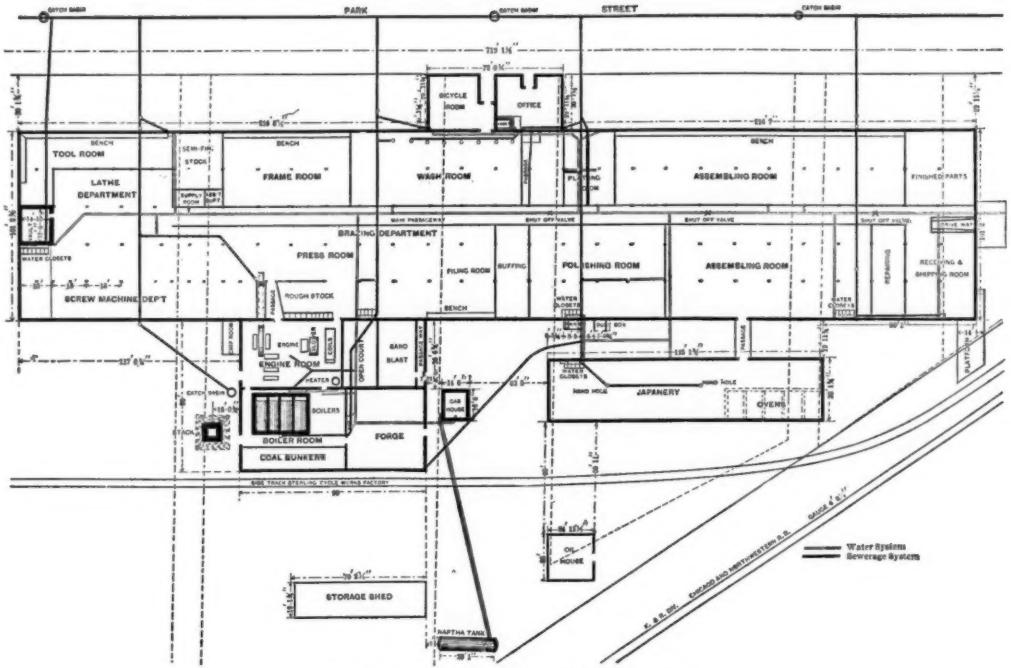


ELEVATION, GATES IRON WORKS, CHICAGO, ILL.



GROUND PLAN, GATES IRON WORKS.

Showing individual-room offices on second floor overlooking shop floor and facilitating inspection; single floor, open structure.



STERLING CYCLE SHOPS, KENOSHA, WISCONSIN.

Main building 500×100 ft. with single floor and open structure, separate japannery, 1895. For exterior view see page 288.

MINOR MINERALS OF THE UNITED STATES.

By David T. Day.

THE mines of the United States yield an average annual product worth $600,000,000. While this product fluctuates greatly according to industrial prosperity, it increases with the growth of population. Indeed, while our population increased only twenty-five per cent. from 1880 to 1890, the mineral product increased just three times as rapidly, or from $350,000,000 to $619,000,000. We should, therefore, in 1900 normally produce about an even billion dollars in minerals.

We record about fifty mineral industries, each contributing a distinct product. Nevertheless, nine-tenths of the total is furnished by a dozen minerals, and more than a third by two,—coal and iron. The rest are the minor minerals.

AVERAGE VALUE OF MINERAL PRODUCTS OF THE UNITED STATES.

	Millions of Dollars.		Millions of Dollars.
Bituminous coal	120	Aluminum	$\frac{1}{2}$
Pig iron	100	Whetstones	$\frac{1}{8}$
Anthracite coal	85	Corundum	$\frac{1}{8}$
Silver	75	Feldspar	$\frac{1}{10}$
Building stone	45	Bromine	$\frac{1}{10}$
Gold	40	Barite	$\frac{1}{10}$
Copper	35	Grindstones	$\frac{1}{10}$
Petroleum	30	Mica	$\frac{1}{10}$
Natural gas	14	Manganese	$\frac{1}{12}$
Lead	12	Graphite	$\frac{1}{12}$
Clay	10	Antimony	$\frac{1}{20}$
Zinc	7	Sulphur	$\frac{1}{20}$
Cement	6	Fluorspar	$\frac{1}{20}$
Salt	5	Marl	$\frac{1}{20}$
Mineral water	4	Chrome iron ore	$\frac{1}{30}$
Phosphate rock	4	Infusorial earth	$\frac{1}{40}$
Limestone for iron flux	3	Millstones	$\frac{1}{50}$
Mineral paints	2	Nickel	$\frac{1}{100}$
Quicksilver	1	Cobalt	$\frac{1}{100}$
Borax	1	Tin	$\frac{1}{100}$
Soapstone	1	Magnesite	$\frac{1}{100}$
Gypsum	$\frac{3}{4}$	Asbestos	$\frac{1}{200}$
Pyrite	$\frac{1}{2}$	Platinum	$\frac{1}{2000}$
Asphaltum	$\frac{1}{2}$	Rutile	$\frac{1}{3000}$
Precious stones	$\frac{1}{4}$		

This classification, however, is not the popular one. Popularly speaking, any mineral is minor which is not frequently mentioned in the technical press; but with such a classification every chance discovery which should give a mineral sudden and temporary notoriety would take it out of the list of minor minerals. Thus, one of our most popular mineral products is aluminum; yet it is a very minor mineral product, not worth a tenth of our salt. Tin is even a less considerable product in this country. Indeed, the total tin product of the world is not worth half as much as our common clay products, which make an aggregate value greater than either silver or gold.

Cement, salt, mineral water, phosphate rock, paints, borax, soapstone, asbestos, aluminum, nickel, cobalt, tin, platinum, quicksilver, antimony, gypsum, pyrite, precious stones, asphaltum, whetstones, bromine, bauxite, corundum, barite, manganese, graphite, sulphur, marl, chrome iron ore, infusorial earth, millstones, magnesite, and rutile are the products which we find in the minor mineral column of our mineral wealth. Of them the first six are always millionaires. Some of the others go beyond that limit, but fluctuate widely. The limiting reasons which keep these substances in the minor list are the most really interesting features of them. This limitation is usually due to one of three things,—to a limited market, principally, but in other cases to the difficulty of finding a supply, and, again, to the fluctuations of other industries to which these mineral products are minor tributaries.

Where lack of supply is the trouble, the mineral has obtained a sudden popularity, to which there has not yet been time to adjust the producing conditions. This usually changes in a few years to a surfeited market, and a loss of interest in the mineral because of abundance. But, where the mineral is a very secondary consideration in some other industry, like sheet mica in stove-making or quicksilver in gold amalgamation, its fluctuations are especially uncertain.

Aluminum.—Considering the minerals under the three heads mentioned, we find that aluminum is typical of the substances of which we cannot get enough. Its product has jumped from 283 pounds in 1885 to 950,000 pounds in 1895, while its price has dropped from $8 per pound in 1885 to a minimum of 35 cents in 1895. This total product is not great, comparatively. Still, if the rapid increase continues, we should produce at least 3,000,000 pounds in 1900.

Aluminum's popularity is due to its lightness, whiteness, and freedom from any considerable tendency to rust. It has certain disadvantages, but these are not so notable as is the lightness of the metal. Its production in this country is limited to one firm, in spite of hundreds of patents and applications for patents for methods of making it. The producers have the best process known, and the

patent has been shown to be good. It has not been the policy of the controlling company to offer royalty privileges in so favorable a way as to induce others to go into the manufacture. The nature of this simple process (Hall's) is too well known to need mention, but in its development, and in other investigations in search of new methods, much has been learned of metallurgy, and two valuable substances—carborundum and calcium carbid or acetylid—have been discovered.

Aluminum is an attractive substance for experiment. It is one of the best conductors of heat; it has a very high specific heat; it tarnishes, but does not rust readily. It is easily rolled or drawn into wire; it can be beaten into an extremely thin leaf. It is an ideal casting metal, and the possibilities of hardening it by alloys offer an extremely valuable and even fascinating field for investigation. It is over-used in many directions, but still the demand is beyond the supply. Singularly, most of it has been used in alloy with iron to improve iron and steel castings, but in the future, with decreasing prices, most must go to making kitchen utensils, till it shall drive first copper, and then tin plate, from the field. If the price goes much lower, copper will be menaced in various fields,—such as electric connections. It would then displace also roofing tin and terne plate. Unfortunately for this prospect, there seems comparatively little chance for reducing its cost much below the present rate of 35 to 50 cents.

Sources of Aluminum.—It is a somewhat curious fact that, in spite of the inability of the manufacturers of aluminum to supply the present demand, there is no scarcity of available ores. It is the common impression that clay is the main source of supply. As a matter of fact, aluminum made from clay is an experimental curiosity, and probably will remain so for many years, because there are richer sources which furnish an abundant supply. The supplies which have been drawn upon have varied curiously. The first aluminum made in the United States in any considerable quantity was from Irish and French bauxite, but later bauxite, fairly free from silica, which was discovered in Alabama and Georgia, was used to a considerable extent, the members of the Pittsburg Reduction Company going so far as to acquire large deposits of it. Next, the far more abundant supplies of bauxite in Arkansas were experimented with, but proved too siliceous, a small amount of silica being as great a detriment in making aluminum by the Hall process as is the iron which is found as the considerable impurity in the bauxites of Alabama and Georgia. But, while the southern bauxite was being used in the manufacture of aluminum, being first sent to Syracuse, New York, where it was refined, and then shipped to Pittsburg for conversion into aluminum, the alumina from Greenland cryolite entered as a competing factor. Inasmuch as the

alum into which this alumina normally goes has become a drug on the market at present, this source of supply controls the trade, and is likely to so long as the quantity of aluminum is sufficient, which can be only for a short time. It will then remain an open question which of the various sources will be further drawn upon, with a possibility of using alumina obtained by a double decomposition of the phosphate of alumina which makes up the raw phosphates from Orchilla and other islands. It is possible to obtain phosphate of alumina in comparatively pure condition, not only from these islands, but from several points in Florida. It seems practicable to produce alumina in perfectly pure condition from this source, and to leave calcium phosphate in a condition suitable for the assimilation of plants without further treatment by acid, and to do this as cheaply as crude bauxite can be refined to the necessary extent for making aluminum. Evidently, therefore, there is a supply of aluminum ores sufficient to yield great quantities of the metal without the use of clay. And, before these supplies are exhausted, will come the question as to whether further supplies of bauxite are not liable to be found under the conditions present in the Coosa valley. They will be sought farther to the northeast in the Appalachian system, wherever the geological conditions are similar. These conditions seem to be a very complicated system of faulting extending through the Knox dolomite and into the underlying shales. Hayes has shown that, where this faulting has taken place, it has admitted the downward percolation of water carrying atmospheric oxygen, which has oxidized the iron pyrite contained in these shales. The free sulphuric acid which, in addition to ferrous sulphate, has resulted from this oxidation has dissolved out the alumina, and thus nature has performed one stage of the conversion of clay into aluminum. First it made aluminum sulphate, and alum where the clay also contained potassium, and then this solution, passing upward, was acted upon by the Knox dolomite, forming gypsum and alumina, carbonic acid probably passing off into the air.

Magnesite.—Another mineral belonging in the group in which the supply is by no means equal to the demand is magnesium carbonate, which is in more or less demand according to the extent to which it has been concentrated as pure magnesite or, on the other hand, left with a large proportion of calcium carbonate, as dolomite. A map of the occurrence of magnesium minerals over the United States would show concentrations of this material wherever there is serpentine. We should think particularly of a more or less persistent system of such serpentine rocks in the Appalachian series most noticeable in Maryland and eastern Pennsylvania, and again in western North Carolina—a series which will be referred to as the source of our deposits of

chrome iron ore, nickel, and corundum. Here pure magnesite has been repeatedly noticed, but not in commercial quantities. Again, on the Pacific coast the occurrence of chrome iron ore in belts of serpentine has also been coincident with deposits of magnesite, and in this State there are beds, reported as from five to six feet thick in several cases, and in one case from five to twenty feet, which would be of considerable commercial importance if located near the points of consumption. But the total supply of magnesite so far found in the United States is entirely insignificant compared with the need of this material as a lining for basic open-hearth steel plants, and recourse has had to be made to dolomite as rich as possible in magnesia. The dolomites preferred for this purpose have been obtained, so far, principally in the neighborhood of Bowling Green, Ohio, and other points where the dolomitic portions of the Trenton limestone are easily available; but in the future the Knox dolomite of Alabama and Georgia will become available, as in the course of time the accumulation of scrap iron in these southern States will admit of open-hearth steel works there. But the supply of this material must be in the neighborhood of the points of consumption; hence dolomite containing anywhere from twenty per cent. to the theoretical forty-five per cent. of magnesium carbonate and less than one per cent. of silica will be greatly sought in western Pennsylvania, in Indiana, Ohio, and Illinois, and just at present in northern New York.

The particular reason why magnesium carbonate is better than calcium carbonate for basic linings is that, the greater the proportion of magnesia, the more infusible is the resulting basic open hearth, and the less liable are the bricks to disintegration by slacking.

The sulphite fiber industry also would be greatly benefited by the discovery of cheap magnesite, because magnesium sulphite is more soluble than calcium sulphite,—which takes the gum from the wood, leaving it in the fibrous condition of wood pulp for paper-making.

Mica.—This is another mineral product which certainly belongs to this group—from the economic point of view. It was a very important feature in stove-manufacture for years. Western North Carolina and New Hampshire were the most convenient sources of supply, and these, together with Pennsylvania, New Mexico, and the Black Hills of South Dakota, controlled the market. The demand was so good that prices were high,—$2 to $10 per pound. With so profitable an industry crude mining methods sufficed. Consequently the inevitable reduction in price, due to the substitution of cheaper grades,—*i. e.*, sheets of smaller sizes,—came as a severe blow to the heedless miners in the North Carolina mountains. They had not learned enough about mining economy to be able to improve their

methods, and, where mining was not discontinued, it degenerated into burrowing after such pockets as proved of unusual richness. These occur very irregularly. Mica in small flakes is common enough as a granite constituent, but it is valuable only where the crystals have abnormally developed to huge size. This is the case here and there in a series of three to seven large dikes of granite cropping out along the top of the Blue Ridge in western North Carolina and southward in Georgia. Especially in Mitchell and Yancey counties the mica is found crystallized in large bunches along the walls of these granite masses, where they swell in width. Guided by these indications and largely by accidental discoveries, thousands of pockets have been opened, and hundreds still remain in a condition to partly justify the name of mine. Small pockets worked by ignorant mountaineers furnish most of the present product, thanks to the conservative habits of the men rather than to the profit they make. They carry their product many miles to the country store, and exchange it for supplies. There is little which can stop this irregular supply, so long as any price for the product remains. Where the mines are large enough to justify account-keeping, they have closed down to avoid actual loss. Not long after the decrease in demand due to smaller sizes of mica in stoves, it rose again higher than ever by demand from the electrical industry for building up armatures. Unfortunately for the miner, India came in in 1884 with a new source of supply, which the McKinley tariff of 35 per cent. could not stop. So that to-day, while the consumption is far greater than the amount we supply, the prices are low, and, were it not for the conservatism of the mountain men, the supply would stop altogether. Grinding the waste has helped the industry, but it cannot reopen mines because of the accumulated waste-heaps. Another innovation is the manufacture of opaque sheets of mica, to order, by building them up with shellac from the larger flakes in the waste heap. The result is good enough for all but the best insulation work.

Platinum.—A much-sought metal is platinum, and fully as useful in the arts as gold. Every one is familiar with the vain search which a popular inventor made for this metal in the southern States, basing his search merely on the fact of the common association of platinum and gold; experience elsewhere should have directed him to the placer gold regions of California and Oregon, where the conditions are somewhat more allied to those in the gold and platinum placers of the Ural mountains. At least the association of platinum with placer deposits from chrome iron-bearing serpentine rocks seems just as important as its association with gold. Platinum mining, as such, does not exist in the United States. A few hundred ounces of crude platinum grains,

together with iridosmine and platin-iridium, are saved from the heavy black sands left behind after removal of gold by amalgamation. So far, the independent search for platinum has not been greatly encouraged by men of large means, although there seems to be fair prospect of good results for such an enterprise, particularly in going north along the Pacific coast. The writer hopes to investigate a considerable number of samples from Alaska as the result of the coming summer's campaign on the Yukon river. The American supply comes almost wholly from Russia by way of the English refineries of Johnson, Mathey & Co., and it is the convenience of this source of supply which discourages any great interest in what we might produce. Still, it would be comforting if we knew just where to turn for a sufficient domestic supply, in case, by any accident, the foreign supply were to be cut off. As to its uses, platinum has become a great convenience in chemical laboratories, both in analytical work and in large industrial operations, such as the concentration of sulphuric acid. In these cases it is simply an equation of first cost of a platinum outfit compared with the cost of repairs when using glass which controls this consumption. There are other industries in which the use of platinum is imperative. No substitute has yet been adopted for the short pieces of wire which pass through the glass of an incandescent bulb, and it is equally as important for the stems of artificial teeth. These uses, together with the platinum contact points in electric apparatus, comprise an ever increasing consumption, which will, however, be checked as the metal grows relatively dearer and thus stimulates the efforts to replace it altogether by cheaper and more accessible substitutes.

Most interesting is the statement of Professor Blake of the occurrence of platinum in the ash from certain coals in New South Wales, and the possibility of very much greater supplies at far lower figures. The following analyses of such coal are due to the courtesy of Messrs. Thirkell & Co., London, who offer to supply the coal at a price near that of the contained platinum.

ANALYSIS OF PLATINUM-VANADIUM BEARING COAL.—NO. 1.

	Per cent.
Carbon	65.2
Hydrogen	4.6
Oxygen	21.8
Nitrogen	1.9
Sulphur	3.8
Water (lost at 100° C)	0.7
Ash	1.7
Total	99.7

APPROXIMATE PERCENTAGE COMPOSITION OF ASH.

	Per Cent.
Metallic Vanadium	25.1
Platinum metals	3.6
Oxygen (combined with above metals)	44.0
Sandy and other earthy matters	27.3
Total	100.0

As the coal contains 1.7 per cent. of ash, this means that it contains 0.44 per cent. of vanadium and 0.063 per cent. of platinum metals. In other words, one ton of the coal will yield 144. 16. 3 of metallic vanadium and 20. 13. 11 of platinum metals.

ANALYSIS NO. 2. SAMPLES DRAWN FROM BULK. PLATINUM-VANADIUM COAL. THE COAL CONTAINED 15 PER CENT. OF ASH.

	Percentage composition of ash.
Metallic Vanadium	2.90
Platinum Metals	0.23
Oxygen (combined with metals)	5.10
Sand, carbonate of lime, &c.	91.77
Total	100.00

The above is equal to

Oz.	Dwt.	Gr.	
146.	17.	8	vanadium in one ton of coal.
11.	13.	8	platinum metals in " "

Precious stones.—These are the object of another industry in which the domestic supply is trifling compared to the total consumption. Gems found here native are, to be sure, turned upon the market, but most of the attempts at systematic mining have shown that it is not yet possible so to direct labor as to find valuable gems in sufficient quantity to pay wages. Exceptions to this are the turquoise mines of New Mexico and the opal mines of Idaho, which promise to be permanent.

Silicified wood, found in Chalcedony Park, Arizona, is the raw material for another industry in Sioux Falls, South Dakota, where this stone is cut into slabs showing the cross sections of tree trunks set off by the brilliant coloring from iron solutions. These slabs have found much ornamental use for many fancy articles, and for clock-faces, table-tops, etc.

(*To be continued.*)

RESTRAINTS UPON THE PRACTICE OF ARCHITECTURE.

By John Beverley Robinson.

IT has recently been seriously proposed to enact various laws restricting the practice of architects upon esthetic grounds. For one thing, it has been urged that the height of all buildings in a block, or on a street, should be made uniform, to prevent the irregular appearance of differing heights. For another, the limitation of the excessive height of buildings has been asked and will probably be enacted, although this is a measure rather in the interest of adjacent proprietors than of alleged artistic importance. Again, a law has lately been enacted which provides that the societies which, from the admitted ability of their members, exercise the function of advisers in public art matters, shall have their power confirmed and their mandates enforced in New York city.

Even as a national matter, a bill has been proposed in Congress creating a National Art Commission which shall control all artistico-political work of the federal organization.

Besides these, the bill to limit competition among architects in New York by means of licenses, has been pushed of late more earnestly than ever ; and will probably before long be engraved on bronze along with the other bills of similar undying fame to protect established traders from the competition of peddlers.

It is not with the laws that are intended to limit the construction of buildings to fixed methods that this article will deal. Architects in general are so unanimously of the opinion that the clerk of a bureau surpasses them so much in honor and intelligence that they cannot get along at all without his *imprimatur* as to make it appear supererogatory to question them further on this point.

Animated by the popular admiration of those who assert a superiority of wisdom, the effort to bridle the unrestrained activity of malignly-disposed architects has gone several steps further ; has been, or is about to be, extended from the regulation of constructive practice, where there is the shadow of a plea of safety to the innocent bystander, to be secured far beyond into the domain of esthetics, where no possible damage can result to anybody in spite of the absence of regulation.

The beginning has been made by the establishment here and there

of various bodies which propose to exercise some kind of censorship of art, whether with or without the addition of the powers of the law.

The gentlemen composing these committees are, no doubt, men of ability,—men of refined taste and the sincerest motives. Their charges that the American people are crude in tastes and barbarous in their public adornments are also, no doubt, in the main true enough.

But their conclusion that it is well for those of refined taste to use measures to force refined designs upon the public is not the only conclusion possible.

It is quite possible that for a time the establishment of some kind of art-censorship would produce an apparent improvement in the quality of public works of art; it is the sequel that is most to be feared,—the continual growth of the idea of repression, the gradual walling-up of all the by-paths, the gradual confinement of all activities to the beaten highway, with not even a look possible over the lofty barriers, into the joyful fields of liberty on each side.

It is just as well to admit at the start that, in comparison with the older nations, America is crude. Compared with London and Paris, as far as the elegances of life are concerned, New York and Boston are of but a wild western type of civilization. We lack the records of the centuries about us; we lack the traditions of race and home; we lack the esthetic sense and critical discernment that come with high cultivation.

But, on the other hand, with the faults of youth we can hardly avoid having some of its virtues. Happy the nation that history wearies, says d'Alembert.

The crudity that comes not from innate viciousness, nor from the world-weariness of decrepitude, but from a sheer desire to accomplish great things hastily, but sufficiently, may be itself reckoned rather a virtue than a fault. Such are most of our faults,—the faults of boyishness, not of depravity. Roughness, rather than coarseness, of taste; energy in doing rather than over-delicacy in method; a desire first to gratify material needs before esthetic needs are even experienced—such are unavoidably the characteristics of a nation that is but a child among nations.

Is it possible that such traits can be changed for the better by authority imposed *ab extra?* Is it possible to force upon the undeveloped taste the pabulum that gratifies the most highly developed? Or, if it be said that it is the development of taste that is sought, is it possible to develop taste by legal compulsory methods? I speak of legal compulsory methods, because to this tend all organizations avowedly based upon a respect for authority. In so far as they ab-

stain from appealing to the law to force their standards upon others, and rely only upon their earnest advocacy by persuasion, no reasonable man can object to them. But, for the most part, no sooner are they well established than they are bent upon "getting a bill passed" at Albany or Washington to relieve them from the labor of preaching their faith and to have it imposed willy-nilly upon the poor savages, the objects of their missionary efforts.

Thus there are now laws made, or urged upon the lawmakers, for half-a-dozen objects with which architecture has to do,—among them the law to restrict the height of buildings, and another law to make all the buildings in a row of the same height, and another to permit architects to practice at all only by license of an all-wise government bureau.

Restrictions of height are defensible, although I think hardly justifiable, on grounds of invasion of the liberty of others, as are also license regulations; when it comes to purely esthetic considerations, such as the uniformity of cornice lines, or the prohibition of all statues that are not approved by a certain committee, there is no pretence of protecting the rights of others possible. And to force objects of art upon a people too young to appreciate them, too young even to be schooled by them, is like forcing a school-boy to throw down his bat and ball and asking him to content himself with a Greek coin or a Cinquecento book cover.

The truth is that all such efforts at implanting an older civilization in unprepared soil must fail; it would be happy if failure were the only thing to be feared.

Too often the enginery of authority succeeds in its self-appointed task, crushes out crudity, and with it dash and spirit, establishes refinement, and with it the mediocrity of all school-standards.

Set up an authority of any kind to which artists must bow, even though the standard at its beginning is one which is admired by the artists themselves, and no sooner is it established than it begins to deteriorate. Outside workers, who must satisfy its criteria, cease to strive for what they really deem best, and try only to do what is known to be suited to the committee's views. Vacant seats in the committee are filled by new names in sympathy with the majority of it.

Gradually an artificial standard is erected; refined or vulgar, according to the quality of taste in the community at large; representing necessarily the average culture and enforcing average estimates of merit.

It is because the organized body represents the community that French art has retained its progressiveness, in spite of its many defects.

The French people is, upon the whole, the most advanced nation, especially in artistic matters. It has always rebelled against authority quite as effectually as the Anglo-Saxon race, although by different methods. The remnant of authoritarianism there could not exist, did it not defer to, and as much as possible embrace, the spirit of liberty that is always asserting itself in spite of the organizations.

The extraordinary part of it is that what we condemn ourselves for most severely, are precisely the things which the French critics speak well of; while what we pride ourselves upon, they treat with coolness if not contempt.

It is not our quasi-classic performances that please them. They have not a word for such clever things as the Madison Square Garden, in spite of its charm.

Originality they must have, before refinement even, so they overlook our most delicate carvings and pass beyond to commend our fifteen and twenty story office buildings, wherein, as the critics say, new problems have been met with skill and originality.

Now to erect the standard of the majority here would be to stifle growth before it has grown strong enough to live in the face of such attempts; American art, instead of working out its own salvation, by its own somewhat halting and wobbling methods, would become a mere dead tradition, imposed upon a careless and tasteless multitude by an artificial and soulless machine.

It is to be regretted that Americans have so far lost the spirit of the founders of the republic that such extensions of governmental functions are entertained at all.

The theory of a democracy is that the majority, although possessed of power to do anything it pleases, voluntarily abdicates that power, and willingly aids in establishing all possible liberty for the minority, in view of the time when the majority itself shall become a minority, and might suffer from any means of oppression that it had permitted to be erected.

In practice we find each party alternately, when it comes into power, bent upon enacting as many new laws as possible, each law requiring as many officials as possible to carry it out, which will be just so many votes to keep itself and themselves in office. Each law, besides, requires an increase of the amount of taxation, and is doubly welcome if it discovers new channels for expenditure. Every dollar spent, every board and committee appointed, every piece of special legislation enacted, means just so many more beneficiaries, so many more votes, so much heavier betting on the reëlection of the party ticket.

The process must defeat itself.

The manifest absurdities and inconsequences of our political seheme, let alone its corruption and trickery, will in the end destroy our superstitious confidence in it. We shall learn, by the saddest experience, what our brains are not big enough to teach us by *a priori* inference, that it is impossible for a majority to do anything and everything it pleases without involving us all in danger.

In the end we shall learn that the only possible function of government is the defense of the liberty of individuals; that art and science and cultivation must be slow growths, and cannot be fostered by governmental methods; and that, even if they could, the cost of indefinite increase of public expenditures becomes too great to bear, the inefficiency of indefinite increase of government bureaus too great to tolerate, the tyranny of indefinite enlargement of governmental functions too heavy for a free people to survive.

REVIEW OF THE ENGINEERING PRESS

WITH A DESCRIPTIVE INDEX TO THE LEADNIG ARTICLES PUBLISHED CURRENTLY IN THE AMERICAN AND ENGLISH ENGINEERING AND ARCHITECTURAL JOURNALS.

INTRODUCTORY

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance ; (2) to supply a descriptive Index to the leading articles published currently in the engineering, architectural and scientific press of the United States, Great Britain and the British Colonies; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

We hold ourselves ready to supply—usually by return mail—the full text of every article reviewed or indexed, and our charge in each case is regulated closely by the cost of a single copy of the journal from which the article is taken.

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The titles and addresses of the journals regularly reviewed are given in full below, but only abbreviated titles are used in the Index. Other abbreviations employed are: Ill=Illustrated.; W=Words; Anon=Anonymous.

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American Architect, The *w.* $6. Boston.
Am. Chemical Journal. *b-m.* $4. Baltimore.
Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Miller. *m.* $2. Chicago.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Archæologist, The. *m.* $1. Columbus, O.
Architect, The. *w.* 26*s.* London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $6. New York.
Arena, The *m.* $5. Boston.
Australian Mining Standard. *w.* 30*s.* Sydney.
Banker's Magazine. *m* $5. New York.
Banker's Magazine. *m.* 18*s.* London.
Bankers Magazine of Australia. *m.* $3. Melbourne.
Board of Trade Journal. *m.* 6*s.* London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick. *m.* $1. Chicago.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
Bulletin Am. Geographical Soc. *q.* $5. New York.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila.
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $1.50. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan, The *m.* $2. Meadville, Pa.
Clay Record. *s-m.* $1. Chicago.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Compressed Air. *m.* $1. New York.
Contemporary Review. *m.* $4.50. London
Cosmopolitan, The *m.* $1.20. New York.
Domestic Engineering. *m.* $2. Chicago.
Electric Power. *m.* $2. New York.
Electric Railway Gazette. *w.* $3. New York.
Electrical Age. *w.* $3. New York.

Electrical Engineer. *w.* 19*s.* 6*d.* London.
Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.
Electrical Industries. *m.* $1. Chicago.
Electrical Plant. *m.* 6*s.* London.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Engineer, The. *s-m.* $2.50. New York.
Engineer, The. *w.* 36*s.* London.
Engineer & Contractor. *w.* $1. San Francisco.
Engineers' Gazette. *m.* 8*s.* London.
Engineering. *w.* 36*s.* London.
Engineering and Mining Journal. *w.* $5. N. Y
Engineering Magazine. *m.* $3. New York
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7*s.* London.
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Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
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Forester, The. *bi-m.* 50 cts. May's Landing, N.J
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Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6*s.* 6*d.* Birmingham.
Gas World, The. *w.* 13*s.* London.
Geological Magazine, The. *m.* 18*s.* London.
Gunton's Magazine. *m.* $2. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8*s.* 8*d.* London.
Improvement Bulletin. *w.* $5. Minneapolis.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30*s.* 4*d.* London
Iron & Steel Trades' Journal. *w.* 25*s.* London
Iron Industries Gazette. *m.* $1.50. Buffalo.
Iron Trade Review. *w.* $3. Cleveland
Journal Am. Chemical Soc. *m.* $5. Easton
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal of Electricity, The *m.* $1. San Francisco.
Journal Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6*s.* London
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Locomotive Engineering. *m.* $2. New York.
Lord's Magazine. *m.* $1. Boston.
Machinery *m.* $1. New York.
Machinery. *m.* 9*s.* London.
Manufacturer and Builder. *m.* $1.50. New York.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7*s.* 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m* $1. New York.
Mechanical World. *w.* 8*s.* 8*d.* London.
Metal Worker. *w.* $2. New York.
Milling. *m.* $2. Chicago.
Mining, *m* $1. Spokane.
Mining and Sci. Press. *w.* $3. San Francisco
Mining Industry and Review. *w.* $2. Denver
Mining Journal, The. *w.* £1. 8*s.* London.
Mining World, The. *w.* 21*s.* London.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York.
Overland Monthly. *m.* $3. San Francisco.
Paving & Munic. Eng. *m.* $2. Indianapolis.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6*s.* 6*d.* London
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Progressive Age. *s-m.* $3. New York.
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Railroad Gazette. *w.* $4.20. New York.
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Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7*s.* London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5*s.* London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10*s.* London.
School of Mines Quarterly. $2. New York.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York
Scientific Am. Supplement. *w.* $5. New York
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scientific Quarterly *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Am. Ins. Electrical Eng. *m.* $5. N Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.
Western Railway Club, Pro. Chicago.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.

ARCHITECTURE & BUILDING

See also "Civil Engineering" and "Domestic Engineering."

Is the High Building Doomed?

AN impartial observer, if called to point out the most notable architectural development of our time, would unhesitatingly select the high building as illustrating the most marked form of modern architectural ingenuity. And, if the same person were asked to point out the most remarkable feature in connection with these mammoth structures, he would unquestionably choose the clamor that architects, throughout this land of high buildings, are making for their extinction. Of course, every one, except the architects, knows that most of those who design high buildings have not the slightest idea how to set about this task. And it is further evident that many of the most recent designs are quite as bad as the earliest. A stoppage in the erection of high buildings would give us a breathing spell; those gentlemen now engaged in the high building business without understanding it might find other means of utilizing their energies; still, the extraordinary demand of the architects that there shall be no more high buildings must rank among the sensational psychological phenomena of our time.

Of the quantity of letters, articles, notes, comments, and utterances of all sorts that have been put forth during this controversy there is not much of real value. The stock arguments of the anti-high-buildingists do not differ much one from the other, and, as a very large number of busy-bodies have concerned themselves in this matter, there has been a great deal said over and over again without much point and certainly without many facts on which tenable opinions could be supported. Fire-chiefs who have no hose that reaches to the top of a twenty-story building; architects incapable of thinking vertically, because their academic training has been horizontal; real-estate owners who wish no more rivals to their own lofty buildings; newspapers that already occupy gigantic structures on open spaces; ladies who are not business women and therefore do not understand the commercial values of high buildings; public men who know nothing of architecture, but repeat what is told to them; all sorts of people who know nothing about the constructive and economic conditions of high building,—these are the people who are making the uproar, and endeavoring to put a stop to the further development of one of the most characteristic, useful, and important phases of American architecture. That is what the anti-high-building agitation really amounts to.

Amid the mass of literature the antis have put out it is a pleasure to read so sober, unbiased, reasonable, and interesting a discussion of the whole problem as Mr. C. H. Blackhall has contributed to the February number of *The Brickbuilder*. He sums up the matter very admirably:

"From a business standpoint, no one can question the desirability of concentration, and this the sky-scraper does most effectually. People may grumble at the shadows cast by the huge structures, and may even, collectively, say that they ought not to be tolerated or allowed; but they answer a public necessity. The best commercial warrant for their being is afforded by the manner in which they rent, and we have only to look at the experience of nearly all the tall buildings which have been erected to see that, however much they may be objected to in theory, as a matter of fact the top offices are the ones rented first, those nearest the ground bring the most money, and the ones which pay the least are midway, or at about the height of what we used to call tall buildings a few years ago. The possibilities of these buildings have so enormously increased the earning capacity of the land that property which would hardly carry itself in former times on a valuation of one hundred dollars per foot can now be made to yield a handsome surplus on a valuation of three hundred dollars, while

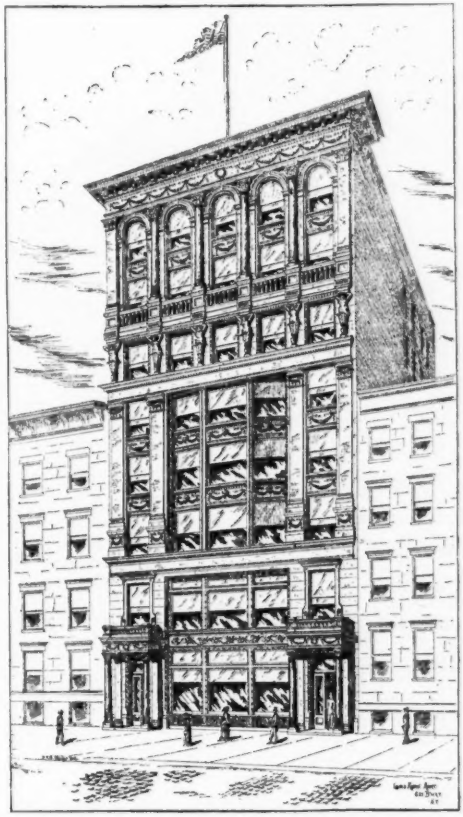
modern machinery and business methods have made it possible to erect these excessively tall structures at a less price per cubic foot than was the rule a few years ago with buildings running up only eighty or ninety feet.

"I believe in the high building; I believe in it architecturally, structurally, and esthetically, when it is properly placed and designed; and I cannot believe the high building need be condemned as such. Very few of our tall office-buildings are in accord with their locations and surroundings, but this is more due to the selfishness of the owners of high-cost land than real lack of appreciation by the architects. We do not need to reduce the height of buildings, but, rather, we want to reform the public taste and the greed of capitalists, so that we will design our tall buildings as monuments, and not as mere money-mills. We want high buildings. It is impossible, under existing conditions, to carry on business in the structures which our fathers found sufficient to their wants. Ten stories is not enough for modern commercial needs, and I will not believe that the possibilities of architecture are so barren that a way cannot be found to carry up our buildings twenty or thirty stories, if necessary, without sacrificing the unity which ought to prevail in a well-regulated city."

The Architectural League Exhibition.

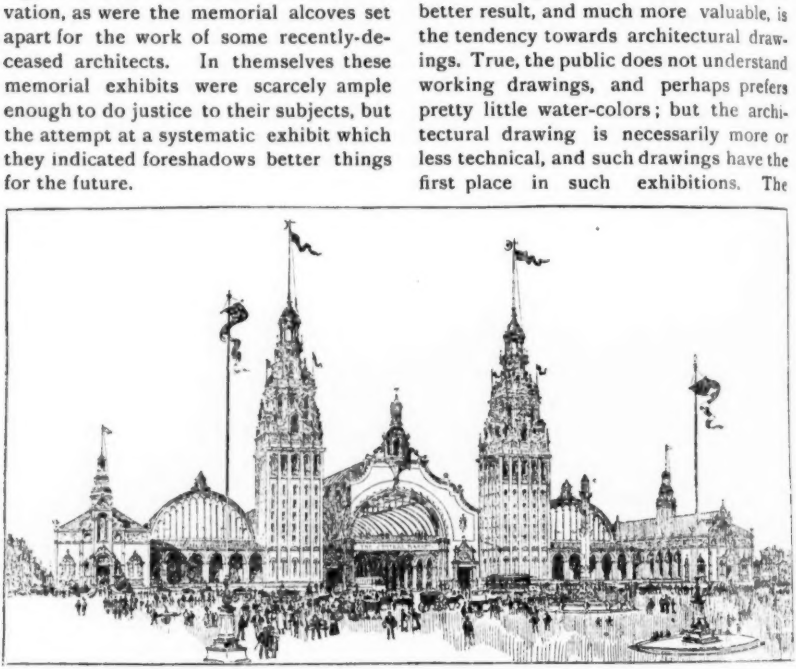
FROM its situation in New York the annual exhibition of the Architectural League of this city has come to be the most important event of its kind in America. Though most of the technical journals print reviews of it, it happens that the most scholarly and thorough are printed in a New York daily paper, the *Evening Post*, which retains on its staff one of the most competent architectural writers of the day.

The recent exhibition of the League suffers, as all its preceding exhibitions have suffered, from the intrusion of decorative designs, examples of fabrics, sculpture, and odds and ends of all sorts, all more or less directly connected with architecture, many of them of some artistic interest, but given an exaggerated position in the galleries, and certainly consuming space that might more properly have been given to architectural drawings. As it is, the space actually given to architecture seems less than that given to the other exhibits. More than once this magazine has pointed out the decorative effect of many of the drawings in the League's exhibitions, which, in previous years, seemed more like a collection of water-colors than an



THE CORN BUILDING, NEW YORK.
Louis Corn, Architect.
[From Architecture and Building.]

exhibit of sober architectural drawings. It is a pleasure to note, this year, a reaction against the evils of the earlier system, and it may safely be said that never before did the League show so many drawings that not only represented architectural subjects, but were real architectural drawings. An arrangement of the drawings in alcoves was also an excellent innovation, as were the memorial alcoves set apart for the work of some recently-deceased architects. In themselves these memorial exhibits were scarcely ample enough to do justice to their subjects, but the attempt at a systematic exhibit which they indicated foreshadows better things for the future.



PROPOSED NEW MARKET, ST. LOUIS, MO. LOUIS MULLGARDT, ARCHITECT.
[From the Inland Architect.]

Perhaps the most striking thing in connection with this exhibition was the relatively small number of small works. The "great" architects were represented in fine force, though it is true enough that some of their designs were not worthy of the reputation of their makers. But the small cottage, the average city house, the unimportant things that make up the bulk of the average architect's work, and by which most architects live, were by no means so numerous as in previous years. It could not have been that such things were not offered; there has been no falling off in building to account for a sudden cessation of this work. It would seem, rather, that the desire of the modern architects to associate their names with some one great building has driven them to concentrate their energies on work of monumental description when possible. This, of course, is one of the results of Frenchitizing American architecture. A better result, and much more valuable, is the tendency towards architectural drawings. True, the public does not understand working drawings, and perhaps prefers pretty little water-colors; but the architectural drawing is necessarily more or less technical, and such drawings have the first place in such exhibitions. The League's show was unusually strong in this—perhaps its most notable—feature.

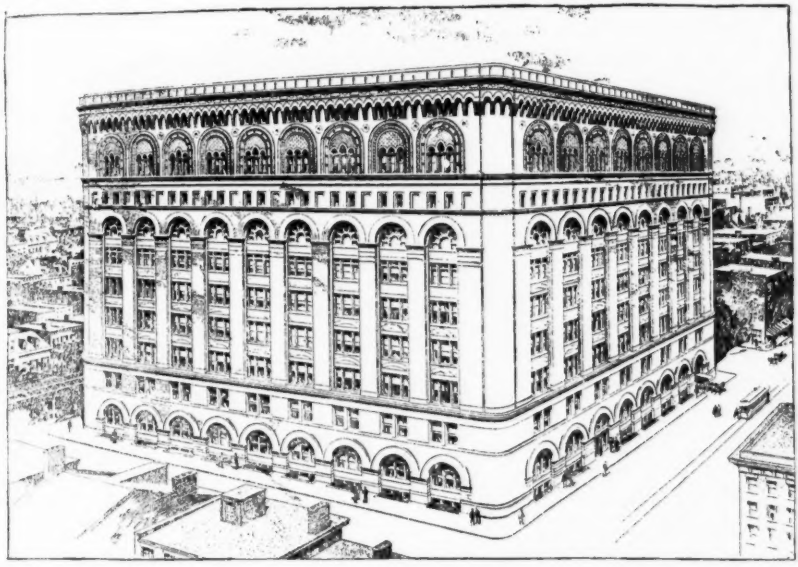
Unfortunately it is quite impossible to look in any of our annual architectural exhibitions for a general review and summary of the architecture of the year. That they should contain such is very clear, and it is equally evident that this could be readily accomplished, if the architects were to take a proper interest.

Illustrations of the Month.

AMONG the illustrations of the month none exhibits such an extraordinary de-

parture from proper architectural ideas as the Corn Building in New York, of which an illustration is reproduced in these pages as a type of what to avoid. The dimensions are moderate, tolerably wide, and not exaggerated in height. Of the base of the design nothing need be said other than that it is commonplace. The second section is made as it is, apparently because its author did not know what to do with his space; the bow window recessed within the building line is a most unhappy conceit that has some vogue at this time in buildings of this class. Above is a single story with gaines between the windows, neither a frieze nor a crowning member, for there are two more above it; possibly it has been interjected here because these figures could be had at a reduction by the half dozen. At all events, it is entirely unrelated to any other part of the building, and this idea of independence, once introduced, seems to have taken possession of the designer, for the two topmost stories are as unrelated to the lower portions as though they were located on another building. It sometimes happens in architectural practice that the material employed in the beginning of a building is changed for a cheaper substance in the higher stories. The present structure is hardly intelligible save on the ground that different designers were employed in the different parts. Possibly it was composed something in the manner of the composite tales one hears of now-a-days.

The new Appraisers' Warehouse in New York, designed in the office of the supervising architect, is a featureless design, yet showing some attempt to conform to the canons of commercial building in being treated with a basement, a superstructure, and a frieze. Its chief merit is its commonplaceness, a not inconsiderable item, since many of the designs of the same origin are most aggressive. In the present instance everything is so hard and cold, so unfeeling, as well as commonplace, that even the additional merit of negativeness is denied to it.



APPRAISERS' WAREHOUSE, N Y. WM. MARTIN AIKEN, SUPERVISING ARCHITECT, WASHINGTON, D. C.

The *Inland Architect* for March prints, among its photogravure plates, some illustrations of three important office-buildings in Chicago, which are the more interesting from the fact that rarely are any interior portions of our great office-build-

ings reproduced in the architectural papers. It also publishes some charming photographs of details from the Guaranty Building, at Buffalo, by Mr. Louis H. Sullivan, whose very great power as a designer, and mastery of form, show constant growth with each fresh undertaking. The photographs in this number are hard and unsatisfactory; their mechanical defects, however, are more than compensated for by the interest of their subjects. It is impossible to criticise the proposed new market for St. Louis, Mo., which is reproduced herewith from this journal, without the aid of a plan. The utility of the two large towers is not apparent, and, apart from these, the design appears burdened with rather more decorative detail than is required in such a structure.

The *Builder* publishes no plates of the first importance this month. The competition design for the Durham Municipal Buildings by Mr. A. T. Bolton and Mr. A. N. Prentice is interesting, genuinely English, and of much originality. Mr. John Belcher contributes an interior and exterior competition design for the Royal Insurance Buildings, Liverpool. It is a most elaborate design with much decorative sculpture. Mr. Belcher has shown great originality in his Renaissance designs, and it need hardly be said, therefore, that this is not the cold, formal copying of classic detail which a Renaissance bank design by an American architect would be. It is in the general style of the design for the South Kensington Museum made by this architect; it does not show,

THE HOTEL CECIL, LONDON. PERRY & REED, ARCHITECTS.
[From the British Architect.]

therefore, an advance on the strong originality displayed in his Institute of Chartered Accountants in London.

Quite in contrast to this is a general store building in Edinburgh, of which several photographs are published in *The Architect*. Above a high ground-floor are four stories, each with a separate Order applied in coupled columns between the windows and at the end of each section of the very varied fronts. The roof line is exceedingly complicated, with high dormers and a low octagonal tower on the corner. It is impossible to describe the unrest of this design, and it certainly is not kind to the spectator to say that it must be seen to be appreciated. Among the photographic plates of this journal are some college buildings at Leeds from designs by Mr. Waterhouse and Mr. W. H. Thorp. Both are in a formal Gothic, with little of the poetry of the style. An interior Hexagon by the latter architect is, however, of considerable interest and well studied.

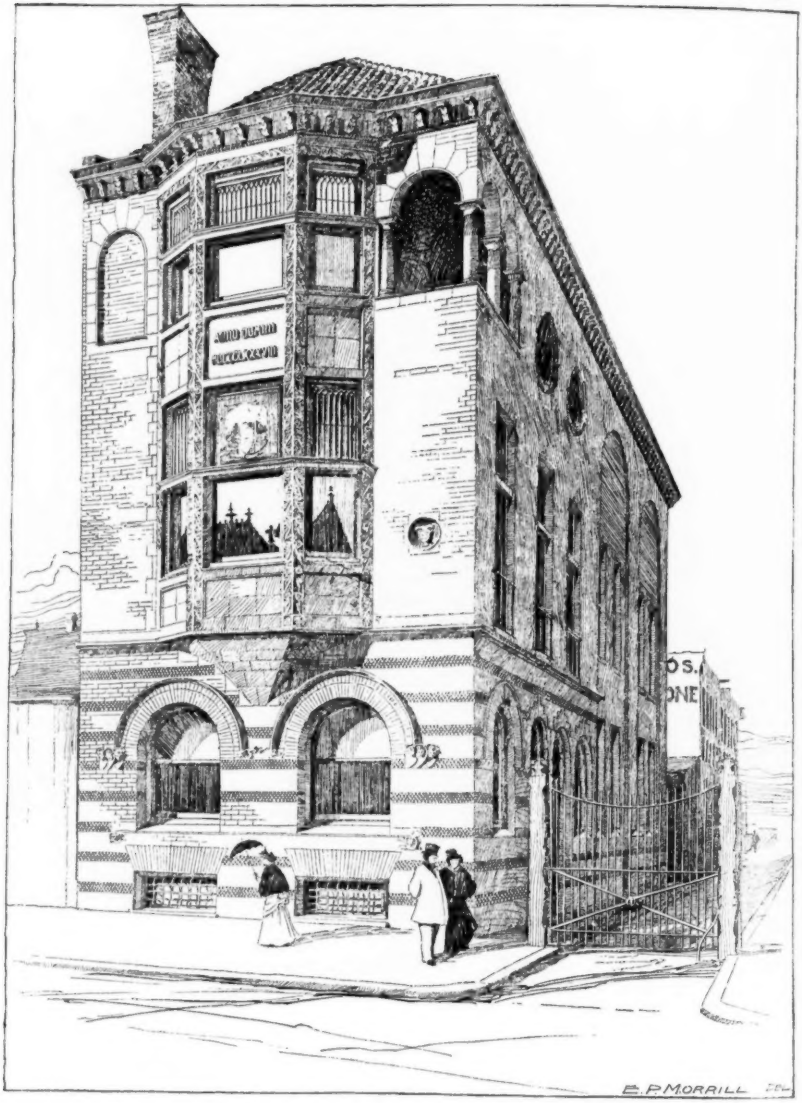
Recent visitors to London have observed, on the Victoria Embankment, a huge structure which has long rejoiced in the distinction of being one of the least satisfactory examples of modern English building and the loftiest commercial structure in the British metropolis. Its origin was due to Jabez Balfour, of unsavory reputation, and for several years was incomplete and unused. This has now been converted into a vast hotel, with many substantial additions; and some illustrations in *The British Architect*, one of which is reproduced herewith, show its present form. The Bible Training Institute in Glasgow, published in the same journal, is an unsuccessful effort in "modern" Romanesque,—a style that, in America, has now almost archaic interest, so rapidly have we moved away from it.

The most interesting photographs in *Architecture and Building* illustrate the new Wool Exchange Building in New York by Mr. W. B. Tubby, a strong, plain design, admirably in keeping with the character of the structure as a wool warehouse, and yet showing, within very restricted limits, the genuine character that the true architect can give to the simplest forms. A residence for W. W. Sherman on Fifth avenue, New York, suffers from the circumstance that the two lower stories are of totally different design and material from the three upper. In a building of such a moderate height, and especially a residence, so sharp a demarcation in parts is neither necessary or desirable. A com-

ROBERT GOULD SHAW GRAMMAR SCHOOL, BOSTON, MASS. EDMUND M. WHEELWRIGHT, ARCHITECT.

[From the Brickbuilder.]

petitive design for an armory in New York is one of those extraordinary efforts in imaginary military architecture that



ST. ANTHONY'S CLUB, PHILADELPHIA. WILSON EYRE, JR., ARCHITECT.
[From American Architect.]

appears to have been arbitrarily settled upon as the type of such buildings, though few of them are of any real merit. The present example is no exception to the rule. This journal also publishes a useful plate of details of Congress Hall in Philadelphia, by Mr. G. C. Mason. The

St. Nicholas Skating Rink, the newest place of amusement in New York, is illustrated with tolerable fulness.

The *American Architect* continues its superb series of American city club-houses, with some additional gelatine plates of the Metropolitan Club in New York and the Army and Navy Club House in Washington. Some of the plates of the former are a little too black in the dark places, but they are fine illustrations of the elaborate interior. The Army and Navy Club is a much less pretentious building, with a severe exterior not only unpleasing, but unexpressive of the purposes of the structure. In charming contrast is St. Anthony's Club in Philadelphia, by Mr. Wilson Eyre, Jr., which is reproduced in our pages. It is a charming design, full of that poetic feeling which Mr. Eyre long ago taught us to expect in his buildings. The closed panel on the left in the upper story, which corresponds to the loggia on the other corner, is, however, a concession to symmetry not usually shown in the work of this architect.

E. D. Chamberlain's Building in St. Paul, Minn., by Mr. Cass Gilbert, is a not very successful attempt to adapt the Renaissance style to the requirements of commercial design. The wide spacing in the lower stories is too suggestive of the steel girders that support the elaborately detailed crowning story. On the other hand, we may be sure that a drawing of the Musée at Nantes, by M. C. Josso, will be hailed with joy and the utmost satisfaction by the Frenchites. It is an admirably studied design of great beauty, and, if carried out, will be entitled to rank among the most notable recent buildings in France. One does not need to be a Frenchite to enjoy a drawing like this; but it will be a quite different thing when we see it reproduced in some of the paper exercises by these devotees of French art in America.

The same journal prints a gelatine plate of the Chicago Academy of Sciences by Patton & Fisher, of which the main feature is the inevitable classic portico, this time with Corinthian columns. Even when this has been lifted up above a basement and sub-basement, it has been found impossible to avoid a considerable flight of external steps. A well-studied design for a Methodist church in Philadelphia is contributed by Mr. G. T. Pierson. Among the other illustrations mention may be made of a couple of sheets of foreign sketches by a Rotch Travelling Scholar. These are light line sketches, usual in work from this source; interesting enough in a way, yet quite without that value which comes from systematic measured work. It is a matter of regret, with the hordes of architectural students annually let loose upon Europe from this country, that more systematic and well-organized work is not undertaken by them. So much remains to be done in this direction that it is an especial pity that the field should be neglected.

The *Brickbuilder* for March gives up its plates to illustrations of schools in Boston by Mr. E. M. Wheelwright. They are admirable types of the class of buildings of which this accomplished architect has made himself a thorough master, and well deserve more attentive study than can be given them in this review.

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†4748. The Glass Mosaics at St. Paul's. Harry J. Powell (A very interesting experiment in decoration which is being worked out by Prof. Richmond in the choir of St. Paul's Cathedral. Much information regarding mosaics is also given). Contemporary Rev–March. 3500 w.

4798. **Restoration of Congress Hall, Philadelphia. George C. Mason (The article is intended to give a brief description of the building and the restorations now in progress). Arch & Build. March 14. 4000 w.**

4799. **Master Builders' Association (Boston) (Abstract of a circular issued by this association with reference to the bill before the Mass. legislature to consolidate certain city departments). Arch & Build–March 14. 1800 w.**

***4800. Saint Front of Périgueux, and the Domed Churches of Périgord and La Charente. R. Phené Spiers (Full paper read at the general meeting of the Roy. Inst. of British Arch., with discussion and illustrations). Jour of Roy Inst of Brit Arch–Feb. 20. 13000 w.**

***4801. Traceries, and Their Position in Architectural Design. William Searle Hicks (Read before the Northern Association. The principles are given as (1) natural suggestions; (2) geometrical and symmetrical dispositions; (3) varied repetitions; (4) simple subordinations; (5) balance of parts; (6) contrast of lines; (7) refinement of outlines; (8) delicacy or lightness of structure; (9) intricacy of convolutions or of interlacings). Jour Roy Inst of Brit Arch–Feb. 20. 4800 w.**

***4812. Electricity in Connection with Building. W. H. Preece (The first part is merely introductory). Elec Eng, Lond–March 6. Serial. 1st part. 900 w.**

***4816. M'Ewan Hall of the Edinburgh University (A description of the building given by W. M'Ewan to the University of Edinburgh). Arch, Lond–March 6. 2800 w.**

***4818. New Streets: Architecturally Considered (Editorial considering the principal difficulties in laying out new streets in old cities; the different methods proposed are discussed, and the relation of the architecture to the street). Builder–March 7. 3500 w.**

***4819. Romanesque Architecture. Ill. Prof. Aitchison (The fifth Royal Acad. Lecture on Architecture this session). Builder–March 7. 4000 w.**

***4849. Hotel Cecil, London, England. Arthur Lee (Illustrated description of a fine hotel recently built upon the Thames embankment). Stone–March. 400 w.**

4870. **The Westfield, N. J., Bank Building (Illustrated description). Eng Rec–March 14. 800 w.**

4896. **Architecture and Engineering. A. D. F. Hamlin (An address delivered before the Architectural League of New York. Setting forth some of the elements which distinguish architecture from building and engineering, and discussing its relations to the science and profession of engineering, etc). Eng Rec–March 21. Serial. 1st part. 3000 w.**

4903. **United States Public Buildings Commission. A. F. Tennille (Bill recommended with view to securing better methods and to give the country a better type of architecture in its public buildings). Arch & Build–March 21. 2700 w.**

***4943. Romanesque Architecture. Prof. Aitchison (The sixth and last Royal Academy**

Lecture on Architecture this session). Builder–March 14. 5000 w.

*4944. Domestic Architecture. Grant Helliwell (Considered in its general and also its specific aspect). Can Arch–March. 3000 w.

*4945. Building Stones of Eastern Ontario. Andrew Bell (Read before the Ontario Assn. of Architects. Notes on the building stones found in eastern Ontario and lower Ottawa valley, embracing that part of the province and Ottawa valley east of a line from the head of the Bay of Quinte to Mattawa, on the Ottawa). Can Arch–March. 3000 w.

*4946. The Historical Buildings in the Hungarian Millennial Exhibition (Illustrated description of the buildings of the great national exhibition to be opened at Budapest on May 2. These buildings are intended to represent the political and intellectual life through which the country has passed during ten centuries of time). Arch, Lond–March 13. 1100 w.

*4947. Masonry. Hervey Flint (Read at meeting of the Arch. Assn., England. A lecture on practical stone work, exterior and interior). Arch, Lond–March 13. 5800 w.

*5003. The Brick Architecture of Holland. R. Clipston Sturgis (The brick work of the public buildings, secular and ecclesiastical, is to be considered and illustrated). Br Build–March. 1200 w.

*5004. The Architect and Contractor. Thomas A. Fox (Introduction to a series of papers that will deal with the problems growing out of the new conditions and requirements in architecture. The next paper will consider the relations between the architect and the contractor). Br Build–March. Serial. 1st part. 800 w.

*5005. Brick Archings (How to build a brick arch. Two methods considered). Br Build–March. 1000 w.

*5013. Clacton-on-Sea Pier and Pavilion (Illustrated description) Engng–March 20. 2000 w.

5039. New Library Building, University of the City of New York (Illustration showing the main features of plan and arrangement of the new building, with brief description). Eng Rec–March 28. 200 w.

*5054. Church Architecture in Scotland During the Past Century. John Honeyman (Abstracts from a lecture given before the architectural section of the Glasgow Phil. Soc). Brit Arch–March 20. 1100 w.

*5055. Electricity Connected with Building. W. H. Preece (A lecture with the purpose of showing how electricity can aid in supplying pure air, pure water, pure food, warmth, light, and the things needed to maintain health). Arch, Lond–March 20. 3000 w.

*5056. Stamboul : Old and New. Richard Davey (A paper read before the foreign and colonial section of the Society of Arts. Interesting impressions of a traveller). Arch, Lond–March 20. Serial. 1st part. 1500 w.

5065. Making Terra-Cotta—Enameled Terra Cotta Fronts for the Steel Sky-Scraper Buildings (Describes the making of terra-cotta, and refers to its rapid growing use as an architectural material, predicting its future popularity). Clay Rec–March 28. 1500 w.

†5073. The Churches of Perigueux and Angouleme. M. G. Van Rensselaer (Illustrated description of these churches, written in popular style, and most interestingly tracing their influence upon architecture). Cent Mag–April. 8500 w.

*5128. Notes on Some Remnants of Mediæval Burgundy. Percy Scott Worthington (Read before the Allied Societies of England. Dealing with some of the prominent architectural features, not only in what is now known as Burgundy, but all the country in France or Switzerland subjected to Burgundian influences). Jour Roy Inst of Brit Arch–March 5. 4300 w.

*5129. Some Observations on Ancient and Modern Building. Arthur Dixon (The comparison of the architecture of ancient times with that of the present century, with a view to discovering why the more ancient impresses students as more beautiful). Jour Roy Inst of Brit Arch–March 5. 2800 w.

5135. The Tennessee Centennial Exposition (Brief description of the buildings with illustrations of the work thus far accomplished). Tradesman–April 1. 700 w.

5137. Civil Service Examination for Building Inspectors (The questions of technical character used at the late examinations for building inspectors, both for iron and steel work and for the general inspection of buildings). Arch & Build–April 4. 1800 w.

5189. Tile Roofing. Max A. Th. Boehncke (An illustrated description of the manufacture and use of the cheapest kind of tile roofs, which have done very good service in Europe for centuries). Brick–April. 1800 w.

*5190. Failure of Buildings. Roger Smith (A lecture delivered in Carpenter's Hall, England. Considering why buildings fail and, to some extent how they fail). Arch, Lond–March 27. Serial. 1st part. 5500 w.

*5194. Concerning Things American. (Editorial review of the Catalogue of the Eleventh Exhibition of the Architectural League). Builder–March 28. 3000 w.

*5195. The Architecture of the Teutonic Order, with special reference to the Restoration of the Marienburg. C. Fitz Roy Doll (A paper read at the Architectural Association, London, with discussion). Builder–March 28. 8000 w.

*5196. The Steeple of St. Nicholas, Newcastle on-Tyne. From the *Newcastle Daily Leader* (Its history and the work of repair). Brit Arch–March 27. 1500 w.

5248. Foundations of the Meyer-Jonasson Building. (Illustrated description of the construction of piers founded on the rock by the use of caissons, sunk by the water process; the building is situated at Broadway and Twelfth Sts., New York. A difficult piece of work). Eng Rec–April 4. 2500 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

The Life of Iron Railway Bridges.

THE editor of *The Engineer* (London, Feb. 14) touches upon this subject in a very interesting manner, showing how the increased demands of traffic have increased the weight of both locomotive and cars. The same bridge now carries an eighty-ton locomotive which was designed for a fifty-four-ton engine, and thus there has been repeated reinforcing and patching of girders at their weaker points. This has not made the bridge of adequate capacity in all cases, and is not liable to do so where bridges have been correctly proportioned. The editor states that the American roads possess too many of these old bridges for public safety, and continues :

"It is comparatively a very simple matter to ascertain if a bridge is quite safe, and equally so to discover if it is quite dangerous, but to determine the line of demarcation exactly where safety terminates and danger commences is frequently a difficult, delicate, and anxious investigation. It is, moreover, one which cannot be left altogether, as a rule, to the judgment of any one particular character or class of mind. The pure theorist would point to his calculations and figures, and unhesitatingly predict the certain collapse of the structure, if the actual stresses exceeded those he had allowed and provided for. As a matter of fact, experience and practice belie this theoretical assertion on nearly every railway in the world. Again, a simple practical man in the capacity of an inspector might detect some slight deformation in some one member of a truss, and honestly conclude that the bridge was in a dangerous condition ; whereas the defect might be of no consequence whatever, and the bridge in a perfectly secure state. In order to arrive at a competent opinion respecting this apparently evenly-balanced question, a searching and rigorous inspection and examination of the existing structure is, in the first place, imperative. Secondly, the ultimate decision must be founded, in addition, upon an accurate knowledge of the amount and character of the stresses upon it originally provided for, and of those subsequently imposed. Thirdly, these two sources of information must be supplemented by a perfect acquaintance with the particular type of girder or truss under investigation, with the quality of the material and workmanship, and with the amount of the maintenance or negligence, as it may happen to be, which has attended the bridge since its erection. A certain amount of practical experience and ability in dealing with the subject must also be possessed by the official upon whose fiat depends the possibly fatal prolongation of the life of an already dangerous structure, or the condemnation of one which has still some years of useful duty before it.

"It is a matter for regret in connection with the subject of our article that tubular bridges are now obsolete; box girders, except under especial conditions, are in the same category ; and plate girders rarely available beyond the moderate span of a couple of hundred feet. All these varieties of the continuous web type have afforded the best record for longevity, and to them may be added riveted lattice girders with several, but not too many, systems or series of triangulations. There are numerous examples of bridges belonging to one or other of these examples in our own country which have far surpassed the quarter of a century allotted to them,—the Menai bridge, for instance. One reason assigned for their superior durability is that the stresses due to both the dead and live loads, as well as to that inseparable but indeterminate function of the latter termed impact, are more uniformly diffused over a larger portion of the main girders, instead of being concentrated, or, perhaps, preferably speaking, located over a comparatively few points. In the former case,

the whole bridge resists *en masse*, as it were, the impact of the rapidly-moving load, while in the latter the effect of the shock has to be counteracted by a very short length of the girders; for it is an axiom that the dynamical effect of a moving load decreases as the separate members of the girders are more remote from those which constitute the locus of its application.

"While it is no doubt both the duty and interest of the engineer to prolong the life of his bridges,—that is, to make them last as long as possible,—the safety of the public is paramount to all other considerations. Iron and steel are cheap in comparison with human limbs and lives."

Welded Steel Mains and Joints.

THE necessity of a light-weight pipe which can be readily put together in isolated localities has developed the steel-pipe business amazingly in the past twenty years. The seams in the steel-pipes were first riveted, but are now welded, and the methods employed in joining these welded sections have been very ably set forth in a paper before the Manchester (England) Association of Engineers by Mr. J. G. Stewart. The following is abstracted from the lecture as printed in *Industries and Iron* (Feb. 28):

"The form of joint to be used for connecting steel pipes together depends upon whether the joint is to be permanent or temporary, and also upon the pressure and the nature of the stresses to which the joint is to be subjected. If the stress to be borne is simply pressure, tending to blow the pipes apart, the designing of the joint is comparatively simplified; but generally there is a bending action, due to the pipes not being supported continuously along the line, to unequal temperature of parts of the pipe, and to shocks and vibration. These latter conditions prevail more or less in all cases of steam pipes. A light and simple form of flange joint suitable for the most moderate pressure is made by bulging and turning over the end of the pipe to form the flange (Fig. 1). It is, of course, apparent that the metal of the pipe is much too thin to form a proper flange, unless thickened up very considerably before or after being turned over, as it forms an unstayed thin surface between the bolts. A flat ring has been put behind for the purpose of helping this thin flange, but a better form of joint may be made by fitting a ring of stamped angle steel behind the turned-over flange, which makes the joint much stronger (Fig. 2). It has, however, the disadvantage of having nothing to hold in the jointing material, which, in the course of time, owing to cooling and heating, probably creeps a little, and is soon afterwards blown out. To obviate this, the cast-steel flange has been made similar to the stamped steel, but with a bored-out recess in the face of one of the flanges which holds the two small turned-over flanges and the jointing material in. The jointing material is thus securely held in (Fig. 3).

"This type of flange can also be made in two parts, which are cast with projections and recesses dovetailing together when fixed in position, and, when bolted up, held as securely as if the flanges were solid. The principal advantage of this arrangement is to enable the flanges to be shipped separately from the pipes.

"It is sometimes an advantage, or a necessity, to have the flange firmly fixed to the pipe; riveting on of flanges is, however, not regarded generally as suitable for steam pipes, as the rivets are liable to leak and the steam has the effect of cutting away the head (Fig. 4). A flange of steel screwed very hard on to the pipe, and with a properly-formed vanishing thread so as to weaken only by the smallest appreciable extent the strength of the pipe, and riveted slightly over on the outside face of the flange, forms a very good joint for a steam pipe, and the one which has been used probably most of all. In this case also a proper recess is made on one of the flanges, which holds the jointing material, and into which a part of the neighboring flange just enters. This joint, when properly made, is capable of bearing extreme pressure, and, like all other joints, it should be proportioned so as to be considerably stronger than the pipes (Fig. 5).

"The type of flange which is pre-

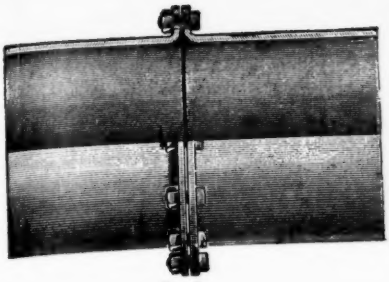


FIG. 1.

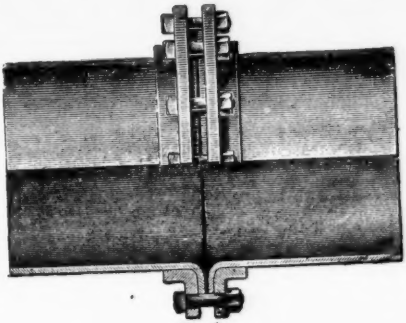


FIG. 2.

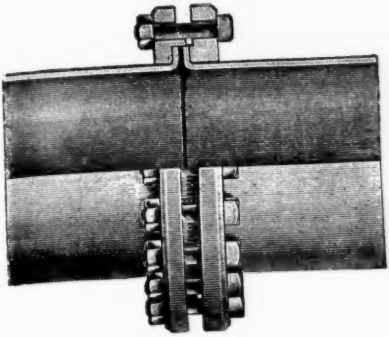


FIG. 3.

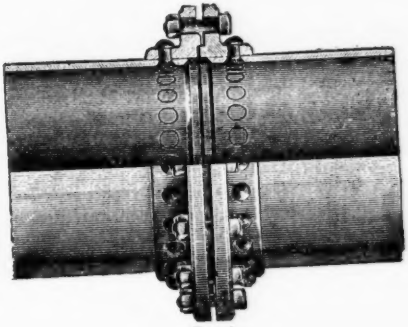


FIG. 4.

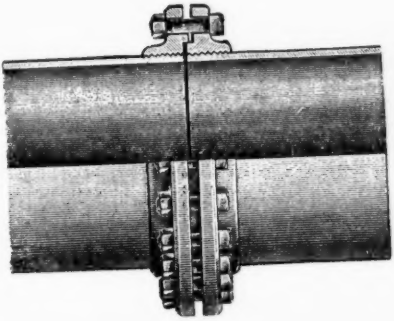


FIG. 5.

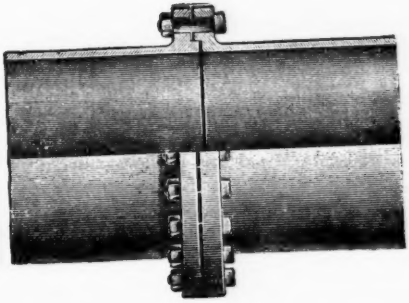


FIG. 6.

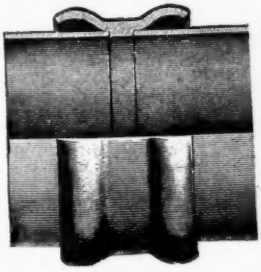


FIG. 7.

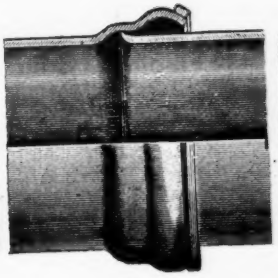


FIG. 8.

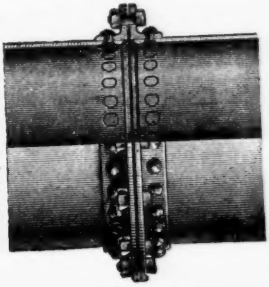


FIG. 9.

ferred for highest pressures and durability is a steel or iron flange welded on to the end of the pipe (Fig. 6), and this type of flange has practically no real advantage over that previously described under ordinary circumstances of pressure, but it has a certain popularity owing to its being solidly welded to the pipe. Various experiments have been made in attempting to pull the flange off the pipe by hydraulic pressure, but, as might have been expected, the pipes have burst before the flanges were moved. This, however, is also the case with regard to attempts to remove the screwed-on flange. For example:

"A 12in. × $\frac{7}{16}$in. tube, with flange screwed on, burst at a pressure of about 3 000 lbs. The pressure sustained by this flange was 144 tons, or 9,000 lbs. per inch of screwed surface.

"The solid welded-on flange has also been experimented upon to a considerable extent, and all efforts to pull this, the flange, from the pipe by internal pressure have failed.

"Another form of joint which, although used sometimes for temporary purposes, is more generally permanent, is the connecting together of pipes by screwed sockets. These have been made for sizes up to 30in. but the labor involved in putting together those large pipes by this kind of joint makes it difficult to see how it can be advantageously used as a removable joint. It is used very commonly for boring purposes.

"Amongst permanent joints, or such as are generally used as permanent joints, there is the collar joint for water mains, formed by a rolled and welded steel collar, enclosing a certain length of the ends of the two pipes to be joined, with a space between the collar and the pipe, which is filled with lead (Fig. 7). The patent inserted lead joint, formed by bulging one end of the pipe so as to hold the other, or spigot, end of the neighboring pipe, and providing that the inside of this annular space is larger than the mouth, thereby forming a lock-joint (which prevents the lead from being blown out), is an improvement upon this, as it consists of only one joint, while the first considered consists of two; and it is very generally used for water-pipes, as the joint can be formed very rapidly, and it provides a certain amount of elasticity, and allows for expansion and movement of the pipe, without almost any leakage; and the leakage, if it does occur, is very easily taken up. The amount of lead required is very small (Fig. 8).

"The only other form of jointing in use for a permanent purpose is that of riveting the pipes together, either by making them conical or telescopic. As this necessitates more work being done, and more time lost at the site where the pipes are laid (often in countries where labor for such a purpose can hardly be got), it seems, as a general rule, not to be so well suited as the two former joints described. Riveted-on steel flanges, with inside riveting flush so as to offer no resistance to water-flow, have also been used, but more commonly for vertical pipes, such as mining mains (Fig. 9 and Fig. 4)."

Requirements for Tensile Strength in Cement Specifications.

THE pulling tests for iron and steel have reached a considerable degree of refinement and accuracy, and necessarily so, for this material in practice is subjected principally to tensile stresses. But why such a degree of refinement should be attempted in cement requirements, when the principal stresses to which it is subject are compression, is more than we can imagine. And, when the refinements of these specifications are compared with the parallel tests of "experts," we are compelled to wonder what the test is worth. If the test itself is not analogous to the usual stresses encountered in practice (not including concrete arches), and there is no uniformity in the results obtained, it would be interesting to know just what the test does tell an engineer, especially where the cement is used in masonry mortar. Mr. J. M. Porter, while in charge of some construction work, discovered that the cement tests, where repeated by different persons, varied widely. He says in the *Engineering News* (Mar. 5): "To find what varying results different persons would obtain

from the same sample of cement, the writer had ten samples taken from as many barrels of a certain brand of Portland cement. These samples were thoroughly mixed together and portioned into ten smaller samples of average quality, which were sent to ten different persons, with a request that a seven-day tensile test, one to three sand, be made according to their understanding of the method proposed by the committee of American Society of Civil Engineers. The accompanying table gives the results obtained from nine different persons, arranged according to their averages."

Laboratory.	Tensile Strength in lbs. of Briquette.								
No.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	Aver.	Water, per cent.	Kind of Machine.
1. R. W. Hildreth & Co., New York....	68	72	74	78	82	..	75	12.0	Riehle, Driven by hand.
2. Washington University, St. Louis, Mo. Prof. J. B. Johnson....	77	94	108	110	122	..	102	Not known.	Fairbanks, Johnson's Clip.
3. City of Easton, Pa. H. R. Fehr, City Eng...	106	112	123	..	..	..	114	10.4	Fairbanks.
4. Columbia College, New York.	125	126	130	137	140	144	133	10.0	Riehle,
Prof. W. H. Burr.....	126	132	138	144	150	153	140	8.0	Driven by hand.
5. Chas. F. McKenna, New York....	143	150	151	155	160	..	153	12.0	Riehle-McKenna Power driven, Rubber Clip.
6. Cornell University, Ithaca, N. Y. Prof. F. P Spalding....	155	160	164	166	172	..	163	Not given.	Lever with water bucket.
7. Lafayette College, Easton, Pa. J. M. Porter.....	171	177	177	178	179	..	176	11.0	Olsen-Porter, Porter Clip.
8. Clifford Richardson, Washington, D. C....	220	224	226	228	228	..	225	10.0	Riehle, Driven by hand, Rubber Clip.
9. Booth, Garrett & Blair, Philadelphia, Pa...	240	246	249	250	252	..	247	12 0	Olsen, Power driven, Rubber Clip.
Average.....	..	..	..	..	..	..	153	10.8	66⅔% Power 33⅓% Hand

"What value has a tensile requirement in cement specifications under the present method of testing when one person obtains thirty pounds, and another one hundred pounds as a result upon the same sample? The cement which one engineer would accept would be rejected by another under the same specifications. Where do the contractor and cement manufacturer stand in this matter? The writer knows that cement can be made to stand almost any tensile requirement within reasonable limits that would ordinarily be made by varying the method of mixing and molding, but, when the mixing and molding are supposed to be done in accordance with a given method, and yet the results vary widely, either the method is at fault, or the results have no value unless weighed by the varying personal equation of the manipulator.

"The writer had two men in his employ, both equally skilled in cement testing, make a tensile test on five briquettes, one to three sand, on the same sample of cement. The tests were made in the same laboratory, the mixing and molding being done at the same time, and the same bath was used, thus eliminating all atmospheric and water conditions. The results were to each other as 85 to 100; and, if the lower one had been taken, the cement would have fallen below requirements, while, taking the higher result, the cement would have passed. The question was, which result to adopt?

"From the figures given in the table it is evident that the personal equation is a decidedly important factor in cement-testing, and, before tensile requirements in specifications can have any meaning, a method must be adopted that will considerably reduce or entirely eliminate this factor. With this in view, the following requirements are suggested:

"(1) Mixing and tempering by machinery, using enough mixture to make a

given number of briquettes.

"(2) Molding under a given pressure.

"(3) Regulation in regar d to the bath, and manner of placing briquettes in the same.

"(4) Abolishing the use of all testing machines applying the load by hand."

The Painting of Iron Surfaces.

IN a prize competition announced by the Society for the Promotion of Industrial Arts Prof. J. Spennrath submitted a contribution giving the results of his experiments in this direction, which have been translated by Mr. Henry Szlapka and published in the *American Gas Light Journal* (March 2). He says that some think that the combination of metallic oxids with linseed oil is a chemical one resembling saponification. He maintains on the contrary, that such is not the case and continues: "After having settled this much, it is a relatively simple matter to determine intelligently whether an oil paint will prove durable under given conditions. Since the destruction of the coat of paint is dependent upon a change in both of its constituents, which are not chemically united, we need only ask ourselves the question what the changes are which the acting materials and forces can produce, first in the pigment, and secondly on the vehicle. Combinations of zinc and lead are easily changeable under certain conditions, and, therefore, to be used with caution. Zinc-white and zinc-gray are changed by smoking hydrochloric acid into chlorid of zinc, after which the linseed oil is attacked. A coat of zinc-white is rapidly destroyed in the open air, because the zinc-white is changed through the action of carbonic acid and water into a crystalline carbonate of zinc, which swells to double the primitive volume; in a closed room such a coat lasts considerably longer, on account of the absence of water, although carbonic acid is present. A similar increase in volume (about thirty-three per cent.) is experienced by red lead, if, by absorption of sulphureted hydrogen, it is changed into sulphate of lead. White lead also is destroyed by the action of sulphureted hydrogen and acids. In spite of this, Prof. Spennrath considers red and white lead, if used in a pure atmosphere, as suitable pigments. Fault has been found with them in cases where the vehicle, and not the pigment, was the mischievous factor. Since red-lead paints are more used than any others, it is no more than natural that more bad places should be discovered in them than in others.

"Pigments which are stable to a high degree, if not absolutely so, are the following: carbon, especially as finely-ground graphite in which it is used in the so-called bessemer paints, as finely-ground charcoal, and as lampblack; heavy spar, which, however, possesses little covering capacity; artificial and natural iron oxids. To the latter class belongs the pigment of the lately introduced 'armor paint.' The professor declares the latter to be just as stable and as perishable as any other oil paint whose pigment can resist the chemical action of the atmosphere and other influences. He condemns the 'senseless' statements of manufacturers who ascribe to their pigments, of which every particle is embedded in a layer of resinous oil, and, therefore, entirely separated from the surface of the iron, an electrical action upon the latter.

"It may be remarked that the object of cooking the oil is to precipitate the slimy substances contained in it, and thus fit it for the better reception of the oxygen. Cooked oil becomes quite hard in one day, while uncooked oil requires two weeks to harden.

"Certain effects of the worst kind cannot be detected at all, as long as the paint adheres to the iron. Such considerations led to the use of paint films, which were obtained by giving a thin sheet of zinc three carefully-applied coats, allowing the paint to dry completely, and then dipping it into sulphuric acid, which rapidly dissolved the zinc, but left the paint film uninjured. Twenty different experiments with such films led to the following conclusions:

"1. Every paint is destroyed by diluted chloric and nitric acids; also by vapors of the same sulphuric and acetic acids. Acid vapors act more rapidly than diluted so-

lutions of the same in water. Diluted sulphuric acid does not attack an oil paint.

"2. Alkaline fluids and gases, ammonia, sulphids of ammonia, and soda solutions destroy any paint rapidly.

"3. Pure water acts more strongly than solutions of common salt, sal-ammoniac or chlorid of magnesium, or natural sea water, which are feared so much as rust-producing bodies. The amount of salt in solution reduces the effect of water on the paint. The destructive action of sea water must be ascribed to the mechanical effect of the waves on the paint covering.

"4. Hot water acts more rapidly than water at ordinary temperature, and may even destroy oil paint in a short time.

"5. The constituents of coal ash soluble in water act destructively, in consequence of their alkaline nature. For this reason the fine ashes thrown up from chimneys and settling on painted iron surfaces are to be looked on as a danger."

Temperature is the worst enemy of paint. At 203° F. the paint films in the professor's experiments became brittle, and shortened several per cent. Graphite paints were less brittle than lead or zinc paints. Of course, this cracking allows moisture to come in contact with the iron, and the result is rust.

It is seen from these remarks that the conditions which affect adversely the durability of protective coatings are numerous. The common means for preventing rust may often be very inadequate, and it seems a very difficult matter to provide any one kind of protection that will withstand all kinds of deleterious influences. However, paint of good quality applied with proper care is probably the best resource for large structures.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

*5012. Accident to Rochester Bridge (This accident to a cast iron girder bridge is interesting in many details. The fine half-tone illustrations show the location and character of the fractures very plainly). Engng-March 20. 1200 w.

5132. Melan Concrete and Steel Arch Bridge, Topeka, Kansas (A five span concrete bridge, stiffened by longitudinal lattice arches, spaced 3 ft. apart. The method of construction is explained fully, and special attention is given to the examination of concrete. An inset plate illustrates the details). Eng News-April 2. 2800 w.

Canals, Rivers and Harbors.

4769. The Report on the Nicaragua Canal (An editorial review of some of the most significant points brought out in the recent report made by a Board of Engineers on the Nicaragua Canal project. This article is confined to showing how entirely insufficient the information now available is, to enable one to form a judgment of the cost and practicability of the scheme). R R Gaz-March 13. 3500 w.

4882. The Report on the Nicaragua Canal (An editorial review of a portion of the report of the United States Board of Engineers on the Nicaragua Canal, going to show the insufficiency of information heretofore collected). R R Gaz-March 20. 1900 w.

4886. English and American Dredging Practice. A. W. Robinson (A letter to the editor discussing the advantages and disadvantages of various forms of dredgers). Eng News-March 19. 1900 w.

*4926. Proposed Ship Canal for Connecting the Bristol and English Channels. W. O. E. Meade-King (A full description of the scheme). Eng, Lond-March 13. Serial. 1st part. 1800 w.

4984. The Report of the Nicaragua Canal Board (The full text of the report is given with a map of the route. It includes the general characteristics of the country, a history of former projects and a full discussion of the present scheme. Also editorial). Eng News-March 26. 36000 w.

4987. The St. Lawrence Water Route to the Sea. Thomas Monro (Address of the retiring president of the Canadian society of civil engineers, in which he expresses some of the reasons why the St. Lawrence River is not more used by commerce). Eng News-March 26. 1300 w.

4989. River Regulation by Suspended Fascines in Bavaria (The devices used by European engineers in directing the courses of rivers are well described, and illustrated by eleven drawings). Eng News-March 26. 1500 w.

*5241. The Problem of Bristol Docks. (The necessary improvements were first reported on by the resident Docks Engineer, and then Mr. Barry, whose estimates are here discussed, was asked to report on the same scheme. The cost of this work is estimated at £2,580,000). Eng, Lond-March 27. 2500 w.

5246. Methods of Work and Special Plant on the Chicago Drainage Canal. (The first of series of articles giving a comprehensive résumé of the

We supply copies of these articles. See introductory.

design and work on this important project. It is well illustrated by maps and profiles). Eng Rec-April 4. Serial. 1st part. 3800 w.

Hydraulics.

4867. Queen Lane Reservoir, Philadelphia (The article upon this interesting problem is very well illustrated by sections, details, maps and plans. The best methods to prevent leaking are discussed). Eng Rec-March 14. 2200 w.

4967. "Water Renaissance." John Birkinbine (A paper read before the Engineers' Club of Philadelphia upon the revival of water power as an engineering specialty). Ir Age-March 26. 1800 w.

4985. The New Water Power Development Below Niagara Falls (The head of water utilized is about 125 ft. Five illustrations showing the location, arrangement, and general appearance of the paper-mill plant are given). Eng News-March 26. 800 w.

5036. Erection of a Long Plate-Girder Railroad Bridge (The requirements of this specification cover all necessary considerations). Eng Rec-March 28. 400 w.

Irrigation.

*4735. Pump Irrigation on the Great Plains. Ill. H. V. Hinckley (Showing that pump irrigation contributes to the preservation of small farming and increases the value of land, and giving directions regarding selection of plant and power). Eng Mag-April. 3400 w.

5245. Some Late Features of the Hydraulics of Irrigation. (From Bul. No. 33, of the Colorado Agricultural Experiment Station, showing that in the Poudre River district, one-third the irrigating water returned to that river, and about 30% on the Platte). Eng Rec-April 4. 900 w.

Miscellany.

4755. Specifications for Asphalt Reservoir Linings at Philadelphia (These specifications on asphalt reservoir linings are said to be the first in the East. Three methods are specified but bids will be received from contractor's designs also). Eng News-March 12. 1400 w.

*4855. Triangulation Preparatory to Alignment of a Tunnel. William W. Redfield (The article is accompanied by a diagram and profile with full description of method employed in connecting two shafts at Minneapolis by a tunnel for the water supply). Jour Assn of Eng Soc-Feb. 1000 w.

4864. The Remuneration of Engineers (Editorial comment upon the smallness of engineers' salaries, as compared with that of specialists in other professions, and the resultant effect on both engineers and their work). Eng Rec-March 14. 600 w.

4883. Tests of Strength of Vitrified Clay (These tests are valuable for reference in designing structures where terra-cotta ware is to be used). Eng News-March 19. 600 w.

4884. A New Formula for the Curvature of Chords in Truss Bridges. Benjamin F. La Rue (The formula is deduced and it is believed to be of practical value in facilitating calculations). Eng News-March 19. 1500 w.

4885. The Cyclotomic Transit. Otto von Geldern (A paper read before the Technical Society of the Pacific Coast, on a transit with a fixed lower plate and a floating exterior ring, thus not interfering with the rigidity of the central spindle. The arrangement is illustrated in section and plan). Eng News-March 19. 2400 w.

4887. Race Track of the National Cycle & Athletic Club at Manhattan Beach, L. I. (A full description, including a general view, plan and sections. The track is a model bicycle racing track designed for high speed). Eng News-March 19. 2000 w.

*4910. Vibrations and Engineering. John Milne (Earthquake vibrations, train and engine vibrations, etc., are discussed from a scientific standpoint and illustrated by view and diagram). Engng-March 13. Serial. 1st part. 2700 w.

*4925. The Elements of Success in Engineering as a Profession (The editor states that success is due more to the character of a man than to his genius. The article is quite interesting). Eng, Lond-March 13. 1600 w.

4931. Economical Designing of Timber Trestles. A. L. Johnson (Abstract from Bul. No. 12 of the U. S. Division of Forestry, giving also Mr. Lindenthal's comments thereon. The various designs are illustrated and dimensions and formulæ given for making calculations). Ry Rev-March 21. 2700 w.

4966. A Great Coal Dock on Lake Superior (The dock is situated at Duluth, Minn., has a storage capacity of 250,000 tons, is 1560 ft. long and 300 ft. wide, has covered bins 950×150 ft. in area, and loading and unloading is done entirely by mechanical conveyors and buckets). Sci Am-March 28. 400 w.

4982. Trolley Cars and Surveying Instruments (A caution to engineers not to put their instruments near the motors when riding on the cars). Eng News-March 26. 600 w.

4993.—$1.50. The Transverse Strength of Beams as a Direct Function of the Tensile and Crushing Stresses of Material. M. Lewinson (The author contends that the neutral axis does not pass through the center of gravity of the cross section of a beam). Trans Am Soc of Civ Eng-March. 2500 w.

4994.—$1.50. Concerning Foundations for Heavy Buildings in New York City. Charles Sooysmith (General considerations which show the danger of overloading the ground on which large buildings are placed). Trans Am Soc of Civ Eng-March. 4400 w.

5050. Notes on Overloaded White Pine. Justin Burns (Showing that a higher allowable unit stress could be used in designing). Ry Rev-March 28. 500 w.

5064. A Florida Kaolin Mine (This interesting description is from the *Jacksonville (Fla.) Citizen*. The process for preparing porcelain clays for market is described in popular style). Clay Rec-March 28. 1800 w.

5149. A Method of Determining the Size of a Beam or Girder from Irregular Loading. Robert D. Kinney (A theoretical discussion with derivation of formula and solution of a problem). Power-April. 1200 w.

DOMESTIC ENGINEERING

Air-Pump and Ejector in Steam Heating. MR. G. W. SCOTT, in *The Iron Trade Review* (March 12), gives data for a comparison of results in the use respectively of these two devices, premising that the function of the air-pump is to produce and maintain a partial vacuum in the returns of the heating coils and radiators, and, aided by a thermostatic valve, "to afford an easy and natural exit for the entrained air and water, while the ejector acts only to remove the air, the water flowing back by gravity.

"Let us suppose that the volume within the return pipes is equal to two cubic feet; and let us first deal with the air-pump, which, we may suppose, has an area of 36 square inches, and a stroke of 12 inches, giving a volume of one-half of a cubic foot for each double stroke. Now, if we assume that at the commencement of the operation the air in the returns is at the ordinary atmospheric pressure of 14.7 lbs. per square inch, then it can be demonstrated that at the end of the fifteenth double stroke the pressure within the pipes will have decreased to 5.1744 lbs., per square inch. And, since the area of the pump is 36 inches, then the work done in the air-pump will be represented by $36 \times 4.7628 \times 2 \times 15 = 5,143,824$, foot pounds,—the 4.7628 being pounds per square inch of average vacuum load.

"Turning now to the ejector, we may consider what is done in this case in the work of reducing two cubic feet of air at an initial pressure of 14.7 lbs. per square inch, to a final pressure, as in the case of the air-pump, of 5.1744 lbs. per square inch. Clearly the work done is due to the velocity of the steam and part of this motion being taken up by the air with which the steam comes in contact. And, if we assume the steam to be of a total pressure of 75 lbs. per square inch, its highest possible velocity due to such pressure and its weight will be about 1,700 feet per second, the corresponding velocity of air at the pressure of one atmosphere being about 1,300 feet per second."

"Furthermore, it is generally conceded that the efficiency of a jet is at the highest when allowed the maximum velocity. And we shall, therefore, suppose the initial velocity of the combined steam and air to be 1,300 feet per second,—a velocity acquired from a certain weight of steam at 1,700 feet per second. Taking the weight of a cubic foot of air at normal pressure to be 0.08 lbs., then the weight of two cubic feet will be 0.16 lbs., and, therefore, the corresponding weight of two cubic feet of air at 5.1744 lbs. per square inch will be 0.05632 lbs. In other words, to obtain this final pressure of 5.1744 lbs. per square inch, it is necessary to remove 0.10368 lbs. of air from the original quantity. Now, it is immaterial whether we remove this air particle by particle, or as a whole; the theoretical consideration is the same within close limits. But for convenience we shall consider it drawn out as a whole. And the weight of steam required for this purpose will be found by the following equation, where x=the weight required.

$$x \times 1700 = x \times 1300 + 0.10368 \times 1300,$$

which gives 0.33696 for the value of x and the weight of steam required.

"Now, the initial energy of this moving body of steam is found by the well-known expression, $\frac{W\ V^2}{Z\ G}$ which gives, in this case, 15,121.34 foot-pounds. And, recalling the conclusion that only 5,143.824 foot-pounds were required for the air-pump, and comparing these theoretical values, it may readily be seen that the ejector requires $15,121.34 \div 5,143.824 = 293$ times the quantity of steam required for the air pump."

It should not be overlooked that these values are quite apart from radiation, friction, and internal losses generally. But, while the air-pump has its friction load to be added to the useful load, and to this extent would require additional steam,

it must not be lost sight of that the friction of the steam and air in the ejector and pipes is considerable in its relative magnitude. And it should be further noted that, while the ejector discharges the air into the atmosphere, which is perfectly proper, it also discharges the accompanying steam, laden with latent heat, in the same direction, which is highly improper, although in the nature of the case unavoidable.

Accuracy of Gas Meters.

ONE of the most prevalent notions among consumers of gas is that gas meters are, as a rule, inaccurate. It is curious to hear some of the remarks made upon this subject by people who think they have not used as much gas as they are charged with in the periodical presentation of bills, and it is difficult to believe that people truthful in ordinary affairs of life intentionally falsify in their condemnation of the fancied unreliability of gas-meter indications.

In a discussion of this matter at a recent meeting of the Ohio Gas Light Association, reported in the *American Gas Light Journal* (April 6), one of the members made a statement the following abstract of which contains the entire truth upon the gas-meter question.

"We had consumers in whom we had implicit confidence, who would tell us there must be something wrong, — that they surely had not consumed the amount of gas that the bill indicated. In such instances it was our rule to take the meter out and invite the consumer to come down and prove it. We explained to him the workings of the meter, which are very simple. And, by the way, I would say that a meter is just as accurate as a watch; no watch was ever made that would keep accurate time for twelve consecutive months; neither is there a meter that would perform accurate work for that length of time; but the meter for its purpose is just as accurate as the watch. After we had explained the workings of the meter to this consumer, we would show him the prover. As you are all aware, a child of ten years can understand the prover. As a matter of course, the meter had stood long enough in the room to become of the same temperature as the air of the room, and, after he had seen for himself the workings of the prover and the meter, he would be perfectly satisfied."

Another member described a method whereby his company is able very often to trace discrepancies between the amounts of gas registered by meters and the rental estimates of those who protest against supposed excess in the indications. He said:

"We have always had our register clerks make a notation of all reports on the bills that were inconsistent, and those were given special attention. Where we are not able to account for the variation, we either read the meter or make inquiries, or in some way attempt to satisfy ourselves, and, if possible, the consumer that is interested in the particular case. In this way we have been able to satisfy the consumer, so that even he was willing to pay a bill that did not seem reasonable. We found that in our meter books it is very easy for the meter reader to extend the consumption. It just makes an extension of one side of one or two figures, and they are instructed, where there is any discrepancy that cannot reasonably be accounted for, to make inquiry of the consumer as to the cause. We find this does away with the necessity of carefully examining the bills in the office, and it is done right at the time our attention is called to it, and, if there is anything to be explained, it can be explained at the time."

In the course of the discussion it was also brought out that ninety-five per cent. of inaccurate meters register against the company instead of against the consumer. A member said:

"Where there is a decided and notable increase in the amount of the bill, the gas company (I am speaking of the moderate-sized gas company, where they are not over-crowded) cannot afford to let that thing go by. If this bill jumps from $5 up to $15 or $20, I do not think I can put in a month's solid time for my company which will earn them any more money than to find out what is the matter. I believe most people who raise a racket about an undue and unreasonable increase in their

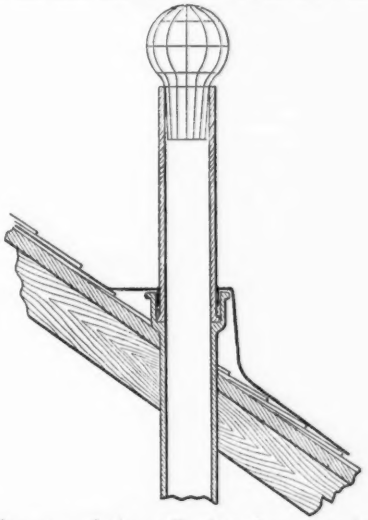
gas bills are honest; I think they are conscientious, when they say they do not understand them. An instance comes to my mind now, where a month's time was spent in solving such a case as that, and I do not believe the company could have the spent same amount of money or time in any other way that would have done as much good. Of course, every community has some members who want to give the gas company a bad name; but there are many more who want to do what is right and fair. A great many people twit us when they come around to pay their bills, but the great bulk of it is mere pleasantry, and not in earnest; but, if a person really thinks he is paying for more gas than he got, the company cannot afford to let it go. I believe, in ninety-nine cases out of one hundred, by taking the necessary time and paying attention to the matter, the cause can be found, and, when it is found, the company is amply repaid for the inconvenience to which it has been put."

While there may be occasional failure in accuracy of meters, the fact remains that, as a rule, gas is measured as accurately by meters as is nearly any other article of domestic consumption by the scales and measures in common use. In most cases where gas bills seem exorbitant, this arises either from forgetfulness of occasions wherein the actual use was greater than usual, or in the surreptitious use of gas by servants in dwellings or clerks in offices. In one instance it was found the clerks in an office had organized a poker club, and were in the habit of burning gas nightly long after business hours.

A Soil-Pipe Roof Connection.

A CORRESPONDENT of *The Metal Worker* (April 4) describes the herewith illustrated method of making a tight connection for soil pipe in a shingled roof, which appears to be so satisfactory that we reprint the description for the benefit of our readers. It seems that with very little modification the method might be extended also to slate roofs.

"With the plumbing regulations of many cities requiring that the vent stack from a plumbing system shall extend through the roof, the problem of making the roof water-tight at the place of exit is presented. Where the roof is flat or of sheet metal, it is a comparatively easy matter. The illustration herewith shows the method of making the roof connection tight, when it is through a shingle roof having a sharp slant. The soil-pipe stack should be cut off so that the hob extends to a short distance—1½ inches—above the roof at the top edge. A piece of sheet lead is best adapted for making a tight connection. A hole should be cut in the lead about 1 inch smaller than the



diameter of the soil pipe that is to be used. It should then be notched with a pair of shears, so that it may be turned down inside of the hub, and should be dressed down around the hub, so that it will lie flat on the roof; and, when used on a shingle roof, it should extend far enough under the shingles so that the manner of breaking the joints on the shingles will prevent water from passing under it. The piece of lead should be sufficiently large to extend on each side some distance away from the pipe, and also at the bottom. From the nature of lead, it can be very readily dressed or beaten up to whatever shape is necessary to cause it to lie flat on the roof and to extend up to the cast-iron hub. After

this part of the work has been done on a continuation of the soil pipe, the stack can be made by inserting a piece of pipe into the hub end, as shown. The joint should be calked with oakum, and then melted lead poured in the hub until it is flush with the top. By this means a perfectly water-tight joint can be made. The illustration shows a wire ball used on the top of the vent stack to prevent the entrance of birds, leaves, and other matter. This style of vent protection, as used by some, is open to objection. It is quite possible for it to be effectually stopped in a snow storm. A better method is to use some sort of a top or cap, which prevents water from entering the vent stack, and which presents a sufficient space for the entrance and exit of air, but not enough for the entrance of birds. With a cap which extends sufficiently over the pipe, there is little danger of the vent becoming entirely clogged with snow or sleet."

Disposal of Waste in Country Places.

DR. HARVEY B. BAYSMORE, in *The Sanitarian* for March, writes of the meager attention paid to this important subject by dwellers in country places. The privies in common use should either be abolished, or be placed far from any well, and their vaults should be made water-tight cisterns. They should be frequently emptied. Far better, from every point of view, is the dry-earth closet, or better still the dry-ash closet, since sifted coal ashes make the very best kind of absorbent, "a quart or so being sufficient at each time of use."

"In this manner we have, too, a method of utilizing the ashes. The closet-pail should be emptied at least once a week, and placed in the sun for several hours. The refuse should be kept in some dry place, and carted away from time to time for use as a fertilizer. Ash-closets, when given a little care, are an odorless, cleanly, and safe method of disposal. Urine wash and kitchen waters are best gotten rid of by some system of irrigation, either subsoil or surface,—preferably by surface irrigation, as being less trouble, less expensive, and perhaps the most efficient method. A small vegetable bed, about twenty by twenty-four feet, for a family of three or four, is all that is required. The slop-receiver can be placed at the corner of the bed, or at an out-of-the-way corner of the house, fitted with pipes and leading to the bed, which should be laid out in furrows. In the summer the furrows can be arranged between the rows of vegetables, so as not in the least to interfere with cleanly cultivation. In the winter the water must be poured into the receptacle only at intervals, and then in sufficient quantity to completely flush the pipes; otherwise freezing would follow, and greatly interfere with the workings of the system. This area, though small, will effectually dispose of an amount of waste water very surprising, and without any odor arising therefrom. The only work required is occasional raking and renewing the furrows. In surface-irrigation sunlight and oxygen are the great prejudicial factors to the growth of pathogenic and saprophytic bacteria, and the organisms of Schlossing, Muntz, and Warrington soon change the filth into ammonia and nitrates. There is no danger of well infection by disposal of liquid in this manner, unless the land slopes directly to the well, for the filth is effectually disposed of in the surface soil."

Sub-soil irrigation is also recommended as a good method for the disposal of all liquid wastes. "The receptacle can be placed at any convenient place, as for surface-irrigation. The arrangement of the bed is very simple. Lay agricultural drain tiles about ten inches below the surface, radiating from the point of departure under the bed in fan form, the end pipes all coming to the surface so as to allow the free circulation of air. A flush tank, of course, can be used, but this unnecessarily complicates the plant."

Where water-closets are used, as in the houses of most wealthy people, the method now to be described is the best substitute for sewers. "Instead of a cesspool, a small, shallow tank should be built in a convenient location, several hundred feet from the house, at the edge of some cultivated field. The house sewer should have pipe connected with this tank. An automatic flush tank with pipe-connection

suitably arranged distributes the sewage over the land appropriated to the purpose. For the small amount of sewage furnished by one family no special preparation of the soil is necessary, save that it has suitable fall and drainage." The author recommends the cultivation of corn on such a field, in preference to grain or vegetables, for in a corn-field the soil is more exposed to sunlight than in the thickly-covered grain-field.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Magazines Journals—See Introductory.

Heating and Ventilation.

4797. Air Pump and Ejector in Steam-Heating. G. W. Scott (Relative efficiency and economy of these devices). Ir Tr Rev–March 12. 1300 w.

4891. Novel Residence Hot Water Heating Plant (Illustrated detailed description of a plant quite out of the common run, designed especially to meet unusual requirements). Heat & Ven–March 15. 1400 w.

4892. The Drop System of Steam Heating. Thomas Barwick (Advantages of the system for many buildings are urged and examples of its application cited). Heat & Ven–March 15. 2000 w.

4893. Fan-Furnace System of Heating and Ventilation. George W. Kramer (Essentials to good results in this system are definitely stated and the article is of general practical value). Heat & Ven–March 15. 2000 w.

4897. Heating of the Armour Buildings at Chicago, Ill. (Illustrated description of central installment for heating twenty-nine buildings, comprising the Armour flats and Armour Mission, Chicago, Ill). Eng Rec–March 21. 1200 w.

5040. Indirect Hot-Water Heating in a Rochester Residence (Illustrated description). Eng Rec–March 28. 500 w.

5249. Heating and Ventilating of a U. S. Custom-House. (Illustrated detailed description. Low pressure exhaust steam is used, and a combination of direct, direct-indirect and indirect radiators is employed, the indirect radiators being supplied with air by fans, etc.) Eng Rec–April 4. 1000 w.

Landscape Gardening.

4875. The Importance of Water in Plant Production. Thomas F. Hunt (A scientific dissertation, useful not only to agriculturists, and horticulturists, but to students of the art of irrigation). Clay Rec–March 14. 5200 w.

4963. John Bartram's Garden To-Day. Ill. M. L. Dock, with editorial (Facts relating to the preservation of John Bartram's garden. Description and historical account). Gar & For–March 25. 3000 w.

5109. What Would Be Fair Must First Be Fit. Charles Eliot (The application of the truth stated in the subject to landscape gardening, with some reference to, and criticism of the professional workers in this field). Gar & For–April 1. 1400 w.

5204. Dangerous Enemies of Trees (Editorial on the beauty and care of trees bordering streets, the necessity of awakening public sentiment for their protection, etc.). Gar & For–April 8. 1500 w.

5205. Proposed Plan for Madison Square, New York City. M. G. Van Rensselaer (The plan of Madison Square as it is, and the plan for its rearrangement as suggested by Messrs. Bell & Langton, landscape architects, is given and discussed). Gar & For–April 8. 1400 w.

Plumbing and Gas Fitting.

*4839. Kitchen Plumbing (Illustrated description of high class work). Dom Engng–March. 500 w.

4872. Plumbing in the American Surety Building (Describes and illustrates in detail the plumbing installment in a building twenty-one stories in height, or 311 feet above the sidewalk). Eng Rec–March 14. Serial. 1st part. 1400 w.

Miscellany.

†4772. The Disposal of Waste in Country Places. Harvey B. Bayshore (Means and methods for the sanitary disposal of wastes and refuse from country homes). San–March. 1200 w.

*5023. Water Analysis (A series of articles designed to explain means and methods whereby the non-medical sanitary officer, or the busy medical officer of health, may make such examinations of water for domestic uses, as will enable him to announce authoritatively, its fitness or unfitness for such uses, without the delay usually necessary when submitting samples to experts for examination and analyses. The first part gives a list of apparatus needed, a table of weights and measures necessary for expressing results, a method of calculation involving only simple decimal arithmetic, and rules for conversion of results). San Rec–March 20. Serial. 1st part. 1400 w.

5041. Report of Sanitary Condition of Boston Schools (Report to the Mayor of Boston, made by a special committee of experts). Eng Rec–March 28. 1600 w.

*5104. The Combustion of Coal and Gas in House Fires. J. B. Cohen and G. H. Russell (Describes experiments instituted to determine how far coal combustion in residences and public buildings,—apart from the use of coal in industrial establishments,—contributes to the smoke nuisance, and how far this nuisance may be mitigated by the domestic use of gaseous fuel). Jour Gas Lgt–March 24. 2600 w.

We supply copies of these articles. See introductory.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Domestic Engineering.

Electric Arc Experiments.

SOME curious experiments made by Mr. A. J. Wurts are described by him in *The Electrical Engineer* (March 18). We make the following abstract of this article:

"While experimenting some time ago with static discharges, I had occasion to pass a small discharge across a 1/32-inch gap, between electrodes which were placed in a heavy glass tube filled with oil and securely corked at either end. Much to my surprise, at the time when the discharge occurred, the glass tube was broken into small fragments; it did not burst as by an explosion; the tube simply fell to pieces. The experiment was repeated a number of times with the same result."

The phenomenon described by Mr. Wurts is accounted for by the displacement of a portion of the oil in the formation of the arc. The effect would thus be the same as though an amount of oil equal to that so displaced were forced into the tube. Reasoning further, he says "that, if the vessel had been relatively stronger than the electromotive force, the arc could not have formed; in other words, it seemed as though the elements were at hand for the construction of a switch capable of opening an electric circuit without an arc.

"Following out these ideas, I constructed an ordinary electric switch of about 100 amperes' capacity, which was suitably located in a sealed cast-iron vessel filled with oil. On placing this switch in a 500-volt direct-current circuit, I opened and closed the switch some eight or ten times on 30 amperes, and, upon removing the stopper from the cast-iron vessel, was surprised to see the oil spurt. On examining the oil, I found it had been considerably carbonized. The accumulation of pressure and the carbonization of the oil indicated the formation of an arc at the switch terminals, which for a time puzzled me considerably, as the formation of the arc had not entered into my calculations. On repeating the experiment, I neglected to replace the stopper, with the result that, when the switch was opened, a column of oil about six feet high was forced into the air. Testing again, with the vessel closed, I detected a slight gurgling sound when the switch was opened.

"Being still puzzled, I determined to see what was going on within the vessel, and had a heavy glass front constructed. Repeating the experiments, I noticed that, on opening the circuit, an arc was formed about the size of a pea. The same arc in air would have been about three inches long. After about a dozen breaks, however, the glass front was shattered, as though struck by a hammer. On further considering these results, it seemed to me that either the vessel had not been entirely filled with the oil, or that the vessel was sufficiently elastic to allow the formation of the small arc noticed. It is not unlikely that both of these conjectures were true. However, the arc which actually formed was so insignificant that I felt encouraged, and proceeded with my experiments, hoping to eventually produce results of practical value.

"My first step was to overcome the pressure which accumulated, due to the formation of gas by the arc in the oil. I placed in connection with the containing vessel a small reservoir, having a direct pin-hole communication with the main vessel; also a valve connection allowing oil to pass from the reservoir into the main vessel by gravity. The pinhole communication was placed in a dome directly over the switch terminals, so that the gases which formed would rise to the top of the dome and pass out into the reservoir,

which latter was only partially filled with oil. The pressure being thereby released in the switch chamber, sufficient oil would flow through the valve communication from the reservoir to occupy the space which had been previously occupied by the gas. This plan proving satisfactory, I proceeded to determine the life of the switch as compared with a similar switch used for the same purpose in the open air. After making about three thousand breaks, I found that the oil had carbonized to such an extent that, with the switch open, there was a current leakage of several amperes. Various oils were subsequently tried, some of which proved better than others. Of these paraffine oil gave the best results.

"I next tried glycerine, and with it made forty thousand breaks. At the end of this test the switch terminals were found to be slightly scarred, the glycerine was black from carbonization, but the current leakage was only a small fraction of an ampere on open circuit.

"Having arrived at this point, I began to experience difficulty with the containing vessel, which now leaked badly, in spite of the best fittings I could procure. To overcome this difficulty, I determined to increase the density of the liquid. It seemed to me that not only would a more dense liquid be less easily forced through the joints, which necessarily enter into the construction of the apparatus, but that it would also more effectually resist the formation of the arc. Satisfactory tests were made with a mixture of precipitated silica and glycerine.

"Aside from the above results, the question 'Can an electric circuit be opened without an arc?' is exceedingly interesting from theoretical as well as practical standpoints. In connection with the electrical engineering problems of the day, it is one of no small importance."

Unsatisfactory Condition of the Incandescent Lamp.

NOT only in Europe, but also in the United States, is this subject attracting much attention. Unscrupulous competition has led to a deterioration of quality which has already injured the electric lighting business, and which, if it be allowed to go on, will result in a serious setback. The electric light has now to compete with the Welsbach burner, and there is also the possibility that it may find a strong rival in acetylene. If those engaged in the business compete recklessly with each other in addition, regardless of the quality of the light supplied, a period of great tribulation for this industry is certain. The following abstract of an article "on the commercial aspect of the incandescent lamp," by George R. Metcalfe (*Electricity*,) exposes the present situation.

"The present relations between the older lamp companies undoubtedly originated in the constant litigation carried on during the life of the fundamental Edison lamp patent. The field of lamp manufacture was opened in November, 1894, by the expiration of the Edison patent, and the successors of the Edison Company entered it with the avowed object of crushing its competitors by underselling them without regard to cost. Within a year the price of lamps was cut to nearly fifty per cent., and in some recent cases to about forty per cent., of the average price in 1894. A few of the weakest companies have succumbed in the struggle during the last year, but, although the trade generally has been demoralized, the effect of cutting prices has reacted quite as severely against the promoters of this policy as against its opponents. This business, however, can never become thoroughly settled as long as this style of competition exists; and, as any chance of monopolizing the business by any one concern has long been an apparent impossibility, the futility of this policy, as well as the financial loss it involves upon the whole trade, has become more than sufficient to show the desirability of its abandonment among the various lamp manufacturers."

Mr. Metcalfe easily demonstrates that this reduction in price has resulted in loss to the consumers, as well as to the manufacturers, on the principle that, if a purchaser gets for fifty per cent. of its former price an article worth only thirty per cent. of its former value, he loses forty per cent. in the transaction. That this is

substantially the kind of effect produced by the cutting of prices in incandescent lamps is made very plain by a proper system of tests, and ample data for proving it are given in Mr. Metcalfe's article; and he alleges that this has been rendered possible by "a general absence of testing facilities, even in large plants. This renders deception an easy matter, and such advantage has been taken of it that the average consumer is now paying considerably more for a given amount of light than he had to pay before the prices of lamps were reduced.

"The makers, ratings of lamps frequently appear to be the result of very poor guesswork, and should never be accepted as accurate, either as to candle-power or efficiency, unless confirmed by the consumer's test. A lot of fifty lamps labelled 16 c. p., and represented to have an efficiency of 3.5 watts, were recently tested by the writer, out of which only six lamps were found correctly rated. They showed a very uniform consumption of 56 watts, but a photometer test showed that forty of them measured 14 c. p. or less, making their efficiency 4 watts and under. This over-rating is encouraged by the general demand for high-efficiency lamps of long life,—conditions that cannot be attained to any considerable extent outside of advertising literature. It can be readily seen that increasing the efficiency necessarily shortens the life of a lamp, and, conversely, lengthening the life reduces the efficiency. The efficiency of a lamp is increased by burning the filament at a higher temperature than is used with low-efficiency lamps, and the effect of this increased temperature on the filament is obviously to destroy it more rapidly in proportion as it burns hotter."

The proportion of first cost of lamps to that of the total cost of electric lighting is so small that efficiency, not low price, should be the controlling consideration in their purchase. "The life of a lamp may be increased at the expense of its efficiency by burning it at a lower heat,—and this is a costly way for the consumer,—or the increase may be by the reason of the filament being made denser and more homogeneous in structure. The latter qualities are, of course, desirable, as they add to the life as well as the efficiency of the lamp."

This proposition is also verified by figures which prove that a long life in an incandescent lamp is not necessarily economical or desirable, and that, after a certain limit has been reached, it is cheaper to purchase new lamps than to continue using the old ones.

"There are means of cheapening the cost of lamps which may save the manufacturer two or three cents, but which cost the consumer two or three dollars. In treating the filaments, the greatest care is necessary to secure uniformity in their resistance and efficiency, and, if sufficient time and attention is not given to this part of the work, the lamps will differ widely in their ratings. The exhaustion of air from the bulb is the most expensive operation in the manufacture of a lamp, and requires considerable time to effect. The most of this time is spent in removing the last traces of air and the occluded gases in the filament, and the cost of the lamp is considerably reduced by stopping this process prematurely. But, if the vacuum is not as perfect as it can be made, the effect is to reduce the efficiency of the lamp and to shorten its life. The reduction of the price of lamps is necessarily followed by a reduction in the amount of labor employed in their production, for which, in the end, the consumers pay a heavy price. If these considerations were taken into account, and better understood among consumers, competition would be directed entirely along the line of quality, and the eventual cost to users would decide the matter of economy without reference to the selling price of lamps."

Magnetic Tester for Sheet Iron.

THIS apparatus (described in *Scientific American Supplement*,) readily measures hysteresis directly and in a single operation, the test being applied to many specimens with little expenditure of time, trouble, or iron. We present herewith an abstract of the description. The instrument is based upon a process of reversal

similar to that which takes place in a transformer, and is intended to be a practical tester for workshop use. The induction is caused to have practically the same value in all samples.

The samples to be tested are cut in a simple form, and are arranged to be readily inserted and removed. The reversal of the magnetism is effected by turning a handle, and the result is indicated by the position of a pointer on a scale. The iron samples are cut or stamped in the form of strips 3 in. long and 5/3 in. wide. The sample is composed of six or seven of these strips for the usual gages of transformer iron, while a smaller number is used, if the material tested is the thicker sheet used in dynamo armatures.

The magnetic tester consists of a permanent magnet arranged vertically and swinging about a knife edge working in an agate trough, a lifting arrangement being provided, like that of a balance, so as to save the knife edge from unnecessary wear and tear. The pointer, which is carried by the upper part of the magnet, is set to zero in the middle of the scale by means of a nut which runs on a screw projecting sidewise from the middle of the magnet, and a more delicate adjustment of the zero may be effected by means of a levelling screw. The bundle of iron strips constituting the sample to be tested is placed in a carrier, and is covered with a vulcanite washer and secured by two clamps. The carrier is made to rotate by means of a friction pulley and hand-driven wheel. This causes the sample to revolve between the poles of the magnet, with the effect that its magnetism is periodically reversed. The work done in reversing the magnetism in consequence of hysteresis causes a mechanical moment to be exerted by the revolving sample upon the magnet, and the latter, owing to its support by the knife edge previously mentioned, and which is in line with the axis of the carrier, tends to follow the sample, and is deflected through a handle which serves to measure the work expended. Since a definite amount of work is done per reversal, the deflection of the field magnet is independent of the speed at which the carrier revolves, and no special care has to be taken to turn the handle of the driving wheel at a uniform rate. The swinging of the magnet is checked by a dash pot below, and the stability is adjusted to give any required degree of sensitiveness. The operation of testing is effected by the insertion of the sample, and, after reading the deflection of the pointer toward one side, the observer reverses the direction of rotation, reads the deflection toward the other side, and takes the sum of the two readings as the total deflection. The deflection is proportional, or approximately so, to the hysteresis of the iron, even when a comparison is made of samples widely different in quality. To insure that this shall be so, a considerable air space is left between the magnet poles and the ends of the sample, with the result that such variations of permeability as are liable to be met with in different samples of iron are almost without influence upon the total induction through the iron. The dimensions and strength of the field magnet are so proportioned with reference to the section of the sample and to the extent of the air-gaps as to cause the induction to have a value fairly representative of transformer work. In a tester exhibited in operation before a meeting of the Institution of Electrical Engineers, the induction was about 4,000 C. G. S. units, with the normal size of test sample. By increasing or reducing the area of section of the sample the intensity of the induction may be reduced or increased. Within reasonable limits, however, the value of this intensity may be adopted in testing.

If a weight of a sample chosen is equal to that of seven pieces of this material as a general standard, it will suffice, in preparing other samples for testing, to select that number of strips which will give a weight even roughly approximating the standard weight. The nearest whole number of strips will do, and it is necessary to cut a narrow or wide strip to make up the extra weight. Regarding the question of calibration, an exhaustive series of experiments has been made to determine to what degree of accuracy the readings of the magnetic tester correspond to the hysteresis losses as found by ballistic tests for

various samples of iron. A comparison showed that these tests accord well, and that the scalereading of the magnetic tester is nearly proportional to the hysteresis loss. The hysteresis of the standard samples being stated for a given induction, to find the hysteresis for any other induction it is only necessary to use a table of factors, deduced by the author as a general mean from many ballistic samples.

The Velocity of Electricity.

THE present period is one in which the replacement of long-standing hypotheses and conceptions by newer and more scientific ones is slowly, but surely, going on. It is easy to understand how in the infancy of any branch of science, in the attempt to express that which is new, terms may be adopted which, in the light of subquent progress, become so burdensome that they must be abandoned. Because electrical energy was seen to shift its place along a conductor, and because the first conception was that this energy was confined to and within the conductor (in which case there would be an analogy between the flow of a fluid through a restraining and directing channel and the electric flow), the idea of an electric current was conceived. This term is still used for want of a better; but every one at all conversant with the facts perceives its utter inadequacy. It does not fit the facts. When we speak of the velocity or rate of flow of an electric current, we express no clearer idea of the phenomenon than if we spoke of the velocity of electric projectile. Still the terms "electric current" and "electric fluid" have a working value. Like the term permanent gas in physics (although we have learned in recent times that there is no gas yet discovered that is permanent under all possible conditions), the use of the words current and fluid enable us to express modes of action that, without them or their equivalents, we could scarcely discuss at all. They may be regarded much in the way that symbols of unknown quantities are regarded in algebra. By their use we can express their mutual relations without at all knowing the real value or physical significance of what they represent.

With reference to the velocity of electricity the present want of knowledge is well expressed by Mr. Gifford Le Clear in *Popular Science Monthly* for March, when he says it is at present "generally conceded that the velocity may be anywhere from the fraction of an inch per hour to millions of miles per second." An attempt made years ago to find the velocity of electricity considered as a fluid, by timing the transmission of a signal sent from Harvard Observatory to St. Louis, and dividing distance by time, is shown to have been entirely misleading in its results. The reason for this is found in the reaction between the current flowing in the wire and the magnetic field created around the wire by the current.

Artesian Well Power Utilized for Electric Lighting.

IT is only within a very recent period that the streams thrown with force from artesian wells have been used in a tentative and limited way for generating power. *Western Electrician* (March 7) describes an instalment for electric lighting in Chamberlain (county seat of Brule county, South Dakota), driven by artesian well power, which may fairly be said to be the first application of this species of power in a permanent power plant large enough to warrant one in considering the experiment a real beginning. True, this drives only a five-hundred-light dynamo at present, but it clearly demonstrates possibilities worth considering in many localities.

When water was struck, it was found that the delivery of the well was 4 432 gallons per minute, at a pressure of 110 lbs. per square inch; and the available power has been estimated as 100 h. p., constantly exerted. When the water delivery is confined and directed by a 2¼ in. nozzle, it rises to a height of 162 ft.

"The mechanical means employed to utilize and control the power are simple, but effective. An eight-inch ell was attached to the top of the casing of the well, and fifty feet of horizontally-placed eight-inch pipe conveys the water from the

connection to the power-house. Here the volume of water is reduced to a stream about three inches in diameter, which impinges on the buckets of a Pelton water-wheel. This wheel is mounted on a shaft carrying a large driving-pulley, which is directly belted to a 500-light alternator, built by the Royal Electric Company of Peoria, and operating at 1,100 volts. A small exciter is driven from the armature shaft of the large machine. The power is more than sufficient to run the plant to its full capacity, and the five hundred lights are all taken in the city."

Raising or lowering the nozzle regulates the power. "The secondary circuits of the wiring system are operated at 52 volts, and the lamps are constantly kept up to this pressure without difficulty. The lights at present are run from sunset until midnight, and from 4:30 A. M. until sunrise, and by next fall the company expects to have the residences of the city take enough light to warrant all-night running. At present much of the power is going to waste, and steps are being taken to put it to use by running other manufacturing plants, and thus utilizing the full force of the well night and day.

"The well of the Chamberlain Electric Lighting company is said to be the largest artesian well in the United States controlled for power purposes. The well is 675 feet deep and 8 inches in diameter. It is composed of sections of 8-in. iron pipe, inside of which is a 60-ft. length of 6-in. slotted pipe, at the bottom, to prevent the ingress of rocks or other large substances with the flow of water. For a depth of 470 ft. from the surface the main pipe is encased in 10-in. pipe to strengthen it and prevent possible leakage. Both sizes of pipe are firmly seated on layers of granite. Three or four strata of this rock, from 4 to 8 feet thick, of exceptional hardness, were encountered in putting down the well. This granite was the most obdurate that had thus far been encountered in the well region, and it required from two to three weeks' drilling, day and night, in each case, to get through five or six feet of it." This an interesting, and in some respects unique, installment.

Municipal Undertakings.

THE Rochester, N. Y., *Post Express* handles the project of purchasing an electrical plant to furnish light for the new court-house in that city without gloves. It makes no plausible distinction between such a municipal enterprise and the broad question of public control of business enterprises.

"Those who take an active part in politics see their advantage in such a development of government activity; even the honest may view with complacency the increase of political patronage, and for the dishonest there is a greater possibility of illicit gains.

But experience shows that whoever may profit by government control of business enterprises, it is not the public. It is easy to say that if individuals reap a benefit from such undertakings, the public can do the same, but this by no means follows. There is no business of which the profit is sure; where gain results, it is because the enterprise is managed with judgment, with intelligence, and with economy, and, most important of all, because it is managed by those who have their own money at stake.

In all these respects the government is at a disadvantage; its servants are constantly changing, and they assume a brief charge of industries to which they have not given their lives; the only margin of profit is by a rigid economy of operation, and until human nature changes there will be few who insist upon economy when the public is the paymaster. It is for these reasons that, with few exceptions, when the government assumes control of a private enterprise, the public gets poorer service at higher cost. This is not a matter of speculation; it has been demonstrated by experience.

When we compare systems controlled by government with our own railroads, which are exclusively in private hands, we find that we are carried quicker, cheaper, and with greater comfort.

There are a few English and Scotch towns which have enlarged the scope of municipal action with advantage to the citizens; they are exceptionally situated and exceptionally governed.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical and Engineering Journals—See Introductory.

Lighting.

*4811. Islington Vestry Electricity Supply Works (An illustrated description of a new electricity supply undertaking, embodying the achievements of the highest technical skill. The principal feature is the provision that has been made for easy extension and increase in capacity of the station). Elect Rev, Lond-March 6. 12000 w.

*4813. High-Voltage Lamps, and Their Influence on Central-Station Practice. G. L. Addenbrooke (Paper read before the Inst. of Elec. Engs. The first part considers the possible sources of influence on central station practice, and the life of high-voltage lamps). Elec Eng, Lond-March 6. Serial. 1st part. 2700 w.

*4817. Bristol Municipal Electric Supply Station (Description of the details of the station, its outlying network of mains and sub-stations, with history and early stages of development. Illustrated). Elect'n-March 6. 5800 w.

4904. Quick Methods of Testing for Faults in Electric Wiring. A. E. Hutchins (Directions for testing). W Elec-March 21. 1700 w.

*4906. An Interesting Plant. S. D. Benoliel (A small plant run by a combination of water and steam power at Riverhead, L. I. Illustrated description). Elec Pow-March. 3000 w.

*4923. St. Pancras Electric Lighting (Illustrated description of the King's-Road refuse destructor and electric lighting station). Eng, Lond-March 13. Serial. 1st part. 1500 w.

4948. Incandescent Lamp Efficiency. W. Stuart-Smith (Considering methods of maintaining their efficiency). Jour of Elec-Feb. 1800 w.

4949. Electrical Search-lights in Sea-coast Defense. John T. Thompson (The benefits to the defense from the use of these lights with general information). Elec Engng-March. 1200 w.

5002. Electricity in Algeria (Illustrated description of interesting installation in Tlemcen, Algeria). W Elec-March 28. 900 w.

5113. A New Method of Studying the Light of Alternating Arc Lamps. W. L. Puffer (Abstract of a paper read before the Am. Inst. of Elec. Engs. Describes experiments). Elec Eng-April 1. 600 w.

5138. The Electric Lighting Plant in the American Surety Building (Illustrated description). Elec Wld-April 4. 1200 w.

*5180. Electric Wiring (Remarks on the systems used, their expense and the reasons for using them, with some references to the papers of Mr. Fred. Bathurst, and Mr. Sam Mavor). Engng-March 27. 1600 w.

*5192. The Economical Current Density for Electric Light Mains. James Whitcher (Discussing questions involving points of doubt and difficulty that arise in the application of Lord Kelvin's law for the most economical current density for electrical distributing mains, particularly as they affect electric lighting). Elect'n-March 27. 2800 w.

5218. Electric Lighting in a Pioneer Town. J. W. Dickerson (Description of the plant which has made Cripple Creek a well lighted city and thus contributed to the order which prevails. An account is also given of the proposed installation of a power plant as an addition to the station). Elec Wld-April 11. 1600 w.

Power.

4740. The Generation and Distribution of Current by an Edison Station. J. W. Lieb, Jr. (Read before the New York Electrical Society. The progress made in industrial applications of electricity is shown by a comparison of the details of equipment of the station of 15 years ago, with that of to-day). Elec Rev-March 11. 4700 w.

4805. A Cotton Mill Electrical Transmission Plant. A. F. McKissick (Illustrated description of the installation of the Pelzer Mfrg. Co., of Pelzer, S. C.). Elec Wld-March 14. 1300 w.

4836. Development of Electric Lighting Engines. H. Lindley (Abstract of a paper read before the Northern Society of Electrical Engineers). Elec-March 18 3000 w.

4842. Distributing Power and Light from Single Phase Alternators. Joseph N. Mahoney (The object of this paper is to show a method of utilizing the present simple alternating apparatus for the generation and distribution of power and light by polyphase currents with no more complication than that met with in a three wire direct current system). Elec Eng-March 18. 900 w.

4847. The Direct Connection of Electric Motors with Machines of Various Types. William Baxter, Jr. (A consideration of the advantages and disadvantages). Elec Wld-March 21. Serial. 1st part. 1600 w.

*4909. Design of Dynamos. G. F. Sever (Lecture delivered before the Henry Electric Club. Treating of the elements of good design and bringing to notice points not often considered in text-books). Elec Pow-March. 2500 w.

*5031. The Development of Electrical Traction Apparatus in the United States. H. F. Parshall (The more important details of the machinery especially developed for use in electric traction are discussed and illustrated). Jour of Soc of Arts-March 20. 6800 w.

*5058. On Secondary Batteries for Electrical Locomotion. Desmond G. Fitz-Gerald (The first part discusses the objections from weight in accumulators used for car propulsion and their application for the motive power of the heavier class of vehicles). Elec Rev, Lond-March 20. Serial. 1st part. 2500 w.

†5063. The Evolution of the Storage Battery. Maurice Barnett (An interesting and instructive paper reviewing the progress of the storage battery and followed by an extended discussion). Jour Fr Inst-April. 8800 w.

We supply copies of these articles. See introductory.

5139. Notes on General Electric Alternating-Current Machinery (Illustrated description of the latest types of alternating machinery). Elec Wld-April 4. Serial. 1st part. 1800 w.

*5199. The Regulation of Pressure and the Reduction of Light-Load Losses in Alternating-Current Systems of Electric Supply. E. W. Cowan and Alfred Still (Paper read before the Northern Society of Electrical Engineers, England. The object of the first part of the paper is to set forth what is believed to be the best methods of maintaining constant pressure in all parts of a distribution system under varying conditions of load). Elec Eng, Lond-March 27. Serial. 1st part. 3000 w.

5220 Electric Fans. S. D. Mott (Illustrated description of ventilating fan). Elec Wld-April 11. 600 w.

Telephony and Telegraphy.

4807. The Berliner Microphone Patent Suit. Ill. (The bill of complaint—Berliner's first application and disclaimer). Elec-March 11. 2200 w.

4841. The Swartz "Multiple Rival" Telephone Switchboard (Illustrated description). Elec Eng-March 18. 500 w.

4846. Telephone Construction in the Rocky Mountains. J. W. Dickerson (Illustrated description of the system of the Colorado Telephone Co). Elec Wld-March 21. 1200 w.

5111. Horton's Telegraph Repeater (Illustrated description). Elec Eng-April 1. 1000 w.

5122. Twenty Years' Progress in Telephony. John C. McMynn (Abstract of paper read before the Chicago Elec. Assn. Historical account). Elec-April 1. 2800 w.

*5193. On Telephonic Disturbances Caused by High-Voltage Currents. V. Weitlisbach (Translated by C. S. du Riche Preller. The paper is a report just published at Berne—*Blätter für Electrotechnik*). Elect'n-March 27. 4500 w.

*5198. Telephone Exchanges and their Working. Ill. Dane Sinclair (Paper read before the Inst. of Elec. Engs., London). Elec Eng, Lond-March 27. Serial. 1st part. 1500 w.

5219. Telephony and Involved Interests. E. F. Frost (A discussion of the conditions affecting the telephone interests, especially as they relate to the press). Elec Wld-April 11. 1400 w.

5223. Regulation of Telephone Rates. J. E. Keelyn (A discussion of telephone rates. The writer holds that a combination "flat" and "sliding scale" rate should be applied to the public exchanges. The abuse of free telephones is also discussed). Elec-April 8. 2000 w.

Miscellany.

4835. The Electrical Combine (Editorial on the combination of the General Electric Co. and the Westinghouse Co). Elec-March 18. 3000 w.

4843 Can an Electric Circuit Be Opened Without an Arc? A. J. Wurts (Results of experiments made with a view to arc suppression in switch contacts). Elec Eng-March 18. 1000 w.

4862. Separable Armature Coils. Ill. William Baxter, Jr. (Their shape and construction; also their advantages and disadvantages). Am. Mach-March 19. 2300 w.

*4905. Notes on Protection Against Lightning Collected During the Summer of 1895. A. J. Wurts (Notes taken during the summer of 1895, for the purpose of obtaining information regarding lightning arresters on the McKeesport and Wilmerding Railway). Elec Pow-March. 1000 w.

*4907. Principles of the Magnetic Field. Frederick Bedell (A study of the magnetic circuit, giving particular attention to its action in connection with alternating currents, as given in the first number). Elec Pow-March. Serial. 1st part. 2800 w.

4937. How the Electric Current is Generated. Sydney F. Walker (Traces the generation from the energy stored in coal or water, through its various conversions). Am Gas Lgt Jour-March 23. 1800 w.

*4942. Paralleling of Alternators. Robert Hammond (Abstract of paper read before the Northern Soc. of Elec. Engs. The latest information on this much discussed subject). Elec Eng, Lond-March 13. Serial. 1st part. 4800 w.

4957. Electrical Engineering at the University of Nebraska. T. C. Martin (Illustrated description and historical account of the University; its departments are treated separately and much interesting information given). Elec Eng-March 25. 3500 w.

4959. Removal of Wires in Boston. Ill. (Abstracts from the report of Commissioner John R. Murphy, giving some details relating to the work done by the various wire companies). Elec Rev-March 25. 3200 w.

4996. A Simple Method for the Measurement of Electric Current. Ichiro Goto (Method for measuring current requiring only a scale, and magnetic needle). Elec Wld-March 28. 300 w.

*5057. Testing Secondary Cells (A review of some points of scientific interest, relating to secondary batteries brought out in a case tried recently in the London courts). Elec Plant-March 1. 5000 w.

5060. On Electrical Discharges Through Poor Vacua, and on Coronoidal Discharges. M. I. Pupin (The first part is an introductory with brief description of the experimental method). Elec Age-March 28. Serial. 1st part. 700 w.

5114. Sparking of Closed Coil Direct-Current Armatures. George T. Hanchett (Discussion of the subject, the causes and remedy). Elec Ry Gaz-March 28. 2300 w.

5141. Simple but Effective Electric Fountain (Illustrated description of the fountain in the large department store of Siegel, Cooper & Co., in Chicago). W Elec-April 4. 600 w.

INDUSTRIAL SOCIOLOGY

The Telegraph Monopoly.

IN the third part of a series of papers by Professor Frank Parsons under the above title (*The Arena* for March) a mass of statistics presented in proof of the assertion that the Western Union Telegraph Company defrauds the public by watering its stock commands attention. If these statistics be accepted as valid, the extent to which this practice has been carried will account for much of the wealth which the late Jay Gould was enabled to bequeath.

From these figures it appears that the company has issued "sixty millions of stock for ten millions of investment in the purchase department," and that, if the same rule has governed the dividend department (which Mr. Parsons seems to regard as most probable), "the present capital stock of ninety-five millions represents a total expenditure of about sixteen millions of dollars, which, added to the fifteen millions of bonds (raised at various times to cover expenses that could not be met with stock), makes the grand total of thirty-one millions as the actual cost of the Western Union system."

Prof. Parsons then proceeds to estimate what would be the actual value of this property, if it were in good condition, which he declares is not the case; and, from data which he gives, he finds this value to be about twenty millions, inclusive of lines, patents, instruments, and appliances.

"The bondholders own fifteen millions of the plant, and five millions is all the physical value that is left for the stockholders. After paying six per cent. on the bonds, the public should not be asked to pay the stockholders more than six per cent. on five millions, for that is substantially what they own of the plant above the mortgage, and they have no moral right to ask the public to pay interest on the franchise which was created by the public and is kept alive by its patronage. The expenses of the business, including depreciation, plus a fair interest on the value of their investment, is all they have a right to ask. The public contributed the franchise on which a value has been placed of about ninety millions out of a total one hundred and ten millions, so that, on the principles of parnership, the public ought to get $\frac{9}{11}$ of the profits." He next proceeds to consider the question of profit.

"Justice gives fair remuneration to labor, and a reasonable profit to the capital actually entering as a factor into present production. The ordinary corporation, however, cares nothing for justice. It takes all it can get. For 1895 the Western Union reports $6,141,389 profit, and $1,578,584 paid in rentals for leased lines, part of it for ocean lines, leaving it about seven millions of profit for the land plant. Interest on bonds was $893,821, wherefore more than six millions remain as profit on less than five millions of property,—the portion of the plant not covered by the bonds. One hundred and twenty per cent. is a pretty good profit, but it is nothing for the Western Union. In 1874 the dividends amounted to 414 per cent.; the investors got their money back four times in one year. During the war, when patriotic citizens were giving their lives and their money for the service of the public, the Western Union was squeezing the public with all its power, and paying one hundred per cent. dividends a year, not merely on actual investment, but on the total stock,—water and all. Since 1866 the receipts have been four hundred and forty millions; profits reported as such, one hundred and thirty-seven millions, which rises to one hundred and sixty millions with the profits put down under the head of rentals, and to more than two hundred millions with the profits expended in buying rival lines that wouldn't take Western Union stock,—at least President Green tells us that the company has spent more than sixty-one millions in cash to

buy opposition lines, and, as the balance sheets show that these sixty-one millions did not come out of reported profits, they must have come out of unreported profits, except so far as provided for by the bonds. There are other additions to be made on account of new construction put down to operating expenses. It is impossible to ascertain precisely the sum total of Western Union profits; even if all the items were reported, it would not do to be too sure they were correctly stated, for corporation bookkeeping is a very flexible affair. There seems, however, to be good reason to believe that at least half the receipts have been profit. And these millions have in a large part been received by men who put almost nothing into the plant. It is probable that the stockholders of the Western Union proper never paid in a half million dollars from first to last. And John Wanamaker says that 'an investment of $1,000 in 1858 in Western Union stock would have received, up to the present time, stock dividends equal to $100,000, or 300 per cent. of dividends a year.' Think of it! Getting your money back a hundred times in cash, and fifty times more in good interest-paying property!"

"A reasonable merchant, manufacturer, or landlord is satisfied to pay for his property himself, and get ten per cent. profit on his capital, out of which profit or other capital of his own he expects to make any improvements his business may require. The Western Union man, however, expects the public to pay for his plant and all improvements upon it, and give him three hundred per cent. a year besides. How long are you going to stand that sort of business, my brothers? And even this is not quite all; the Western Union man likes to get a bonus out of the government, when he can do so without awaking the people, and he has sometimes succeeded in getting a bonus that all by itself would pay five times the cost of the line for which it was given."

The Baltimore and Ohio Railroad Relief Department.

THIS department having been in operation fifteen years, a fair judgment of its practicability and utility can now be formed from details and statistics presented serially in *The Railroad Gazette* by Mr. L. W. Reilly (commenced in issue of March 20). The following abstract includes a few of the many interesting facts detailed by Mr. Reilly.

"At the start, the company assumed general charge of the department. It provided office-room and furniture; it gave the services of managers and clerks; it granted the use of its facilities; it became the custodian of the funds; and it guaranteed the faithful performance of the obligations of the enterprise.

"The department is controlled by a special committee of directors of the company. They are aided by two advisory committees, one for the lines east of the Ohio river, and one for the lines west of that stream. These advisory committees each consist of seven members,—the general manager of the road for that division and two employees from the machinery department, two from the transportation department, and two from the road department, elected by their fellow-members. Subject to these committees, but in direct management of the relief department, are a superintendent, an actuary, and a force of clerks.

"The department is divided into three sections, called the relief, the savings, and the pension feature.

"The relief feature affords relief to its members when they are disabled by injury or sickness, and to their families after their death.

"The savings feature affords opportunity to the railroad employees and their near relatives to deposit with it their savings, and earn interest thereon; and to employees only it offers to lend money at a moderate rate of interest and on easy terms of repayment, for the purpose of acquiring or improving a homestead or freeing it from other debt.

"The pension feature makes provision for those employees who, by reason of age or infirmity, are relieved, or retire from the service of the company.

"The railroad contributes to the de-

partment every year the following amounts:

"(1) The sum of $6,000 for the support of the relief feature, or, when not needed for that feature, for the support of the pension feature;

"(2) The sum of $25,000 for the support of the pension feature;

"(3) The sum of $2,500 for the physical examinations of employees."

Membership in the relief feature is voluntary for officials paid more than $2,000 per annum; for employees continuously in the service of the company since May, 1880, and who are not members of the Baltimore & Ohio Employees' Association; clerks; telegraphers in the service; agents receiving commissions; and employees receiving $20 per month or less. Upon all other employees of the road, even those who are under instruction without pay, membership is obligatory, except upon temporary and extra help employed for not more than two days. A medical examiner passes upon the surgical condition of applicants, and the limiting age for admission is forty-five years. There are other important restrictions, limitations, etc., for which those desiring fuller information should consult Mr. Reilly's well-prepared paper.

Members are classified according to the character of their employment, and the general classes so formed are subdivided with reference to their average monthly pay. Members in these classes pay monthly dues ranging from 75 cents to $5, according to their classification. Except where injury or sickness are contributed to by bad personal habits or immoral conduct, members are entitled to benefits as follows:

"First.—Payments while totally disabled by accidental injury received in the discharge of duty in the service, for each day other than Sundays and legal holidays, during a period not exceeding twenty-six weeks at the rate of fifty cents a day for a member of the lowest class, and at higher rate for members of the other classes in proportion to their contributions; and at half these rates during the continuance of the disability after the first twenty-six weeks.

"Second.—Payments while totally disabled by sickness or from any cause other than accidental injuries received in the discharge of duty in the service, for each day other than Sundays and legal holidays, after the first six working days of such disability, and for a period not exceeding fifty-two weeks, at the rate of fifty cents a day for a member of the lowest class, and at higher rates for members of the other classes in proportion to their contributions.

"Third.—Payment on the death of a member of the lowest class from accidental injuries received in the discharge of his duty in the service, of $500, and of greater amounts for the other classes in proportion to their contributions.

"Fifth.—Payment of fees for such surgical attendance as the company's medical examiner approves as necessary in consequence of accidental injuries received in the discharge of duty in the service, at the rates fixed in a schedule adopted by the relief department, when the bills therefor are approved by the local medical examiner. The superintendent will arrange for the admission of members to hospitals, at moderate cost, when requested."

Both the savings and the pension features of the department are worthy of careful study, but they cannot be here outlined. All details of the three features appear to have been thought out in the most careful manner, and the system is obviously an intelligent and well-directed effort in the true line of industrial progress.

High Price of British Consols.

BRITISH consols sold in February at the highest price recorded up to that date. The 2¾ per cents. sold for 109, notwithstanding the fact that they are to become 2½ per cents. in 1903.

Commenting editorially upon this significant fact, Bradstreet's (March 7) first notes that such an investment can yield to the investor only £2 7s. on the £100, and remarks that this indicates "the extremes to which British capital is forced in order to obtain absolutely safe employment." It also notes a corresponding effect upon

English and Scotch railway shares and debentures. *The Financial News* (London, Feb. 18) is then quoted with reference to the probable future interest which British consols will yield.

"It seems highly probable that in a few years consols will be valued on a two per cent. basis. While, to some extent, we may be proud of the apparent advance in the national credit, it is a mistake to suppose that the price of consols is a trustworthy test. If the quotations of government securities were the real criterion of credit, we should hardly see a similar improvement in French and German *rentes*, notwithstanding that the indebtedness of both countries is growing at an uncomfortably rapid rate. The reason of the rise in government bonds almost all over the world—that is, among those nations which have not openly defaulted or given evidence of bad faith—is the ever-increasing demand for fairly safe securities, which must continue to grow as the accumulated wealth of the world increases. In our own country [England] there is additional reason for the advance in consols, because the demand is automatically augmented year by year on account of the savings banks, while the supply is steadily diminished by the operations of the sinking funds. Unless the scope of investment should be enlarged, it is obvious that the funds of the post-office savings bank will soon drive consols to a still more extraordinary price than that at which they stand now, provided that conditions are not changed by war, or any other event which would involve England in a heavy outlay. But, leaving consols out of the question, the lower rate of interest now obtainable in all gilt-edged securities is clear proof that demand has so far exceeded supply that investors have educated themselves to be content with a smaller return than that which was considered the irreducible minimum not many years ago."

Bradstreet's finds a curious contrast in the following: "Not so long ago a leading financial authority declared that it was dangerous to buy consols at 102." Now, the *Financial News* thinks it dangerous to sell them at 109. The same journal, commenting upon the fact that, at the date of its article, the official minimum of the Bank of England had stood at 2 per cent. for practically two years without alteration,—"a longer period than has ever been known since the bank act was passed in 1844."—asserts that "even this figure does not represent the real value of money" during the term since the reduction of the rate to 2 pér cent. (Feb. 22, 1894.)

"Hardly at any moment has the open market rate for three months' bills approached 1½ per cent., and that in spite of many occurrences which tended to raise the value of money, at least temporarily. A year ago, for example, the issue of part of the United States loan in Europe led to the expectation that large quantities of gold would be shipped to New York. But our supplies of bullion were replenished from other quarters to such a degree that the market hardly felt the influence of the comparatively moderate drain of gold to the United States. Since then, the South African boom gave rise to considerable demands for accommodation, but without much effect on the market. When the boom began to reach dimensions inconsistent with safety, some of the banks diminished the advances made by them to the Stock Exchange, and so helped to precipitate the collapse. The trouble which followed in some continental centers reacted to a slight extent on the London money market, but rates did not stiffen much. But it is needless to dwell on the fact that outside rates for money have been almost as consistently low during the past two years as the bank rate has been."

From these causes the rise in other high-class securities—debentures and preferred stocks of railways—has paralleled that of consols. "Consequently much attention has been given to the ordinary shares of home railways, and at the present London & Northwestern's common stock, which in 1895 paid 6⅜ per cent. dividends, sold at 187⅜ in last September, against 185½ in 1890, when the dividends on the stock amounted to 7¼ per cent. Other examples might be cited, showing that the English investors have to be satisfied with no more than 3 per cent. from home invest-

ments." The undeniable tendency of English capital to increased investment in American securities is thought to be fully accounted for by the facts stated.

The Recent United States Loan.

IT is interesting to note the light in which the financial system of the United States and its workings are regarded in the great financial centers abroad. The recent United States loan, which, as we think, was compelled by this defective system, and the temporary, make-shift character of the loan form the text of some plain-speaking in the March number of the *Banker's Magazine* (London).

The loan is, in one sense, considered a success, since the bids for it aggregated several times the amount called for; but the opinion is expressed that its effect in maintaining treasury reserves is likely to be even more transient than was the case with the preceding loan, notwithstanding the fact that the last loan exceeded the former one. The difference between the two operations is explained as follows:

"The loan of 1894 was taken entirely by the Rothschild-Morgan syndicate, who placed one-half of it in England and the remainder in the States. Not only did the Rothschild-Morgan syndicate undertake to deposit in the United States treasury a certain amount of gold obtained from abroad, but for a given period they pledged themselves to protect the treasury reserves in every possible manner. The issue of bonds placed on this side was so contrived that it was practically impossible for them to be returned to the States for a period of six months. No sooner, however, had the period of the syndicate 'protection' expired than withdrawals from the treasury recommenced, until, prior to the new loan last month, practically the entire sum raised by the loan of 1895 had been lost. Was there ever a more complete picture of financial schemes being hopelessly spoiled by an unsound and illogical currency system?

"And now it would seem that a further striking object-lesson is to be afforded by this latest device for replenishing treasury reserves. Twenty millions sterling have been raised without the assistance of a protective syndicate, and the treasury reserve has been raised to ninety-four million dollars. Confidence, we are told, is returning, while in the same breath we are informed that greenbacks are at a premium. In other words, there is a rush to withdraw the very gold recently deposited. Whether this latest object-lesson in United States finance will be sufficiently convincing to bring home to the nation the impossibility of maintaining their present gold standard on the present illogical currency is a point which may now attract attention. If it does so, that lesson will scarcely have been dearly bought, even at the cost of the recent heavy and almost useless loans."

Arguments for Reciprocity Treaties.

THE advisability of reënacting a reciprocity provision, empowering the president to negotiate reciprocity treaties with foreign governments, having been for some time under consideration by the ways and means committee of the house of representatives, this committee addressed a circular of inquiry to several thousand manufacturers in the United States, designed to ascertain the consensus of opinion of leaders of industry upon this important measure. *The Iron Age* (March 26) prints abstracts from a considerable number of these replies, prefacing them with the statement that more than ninety per cent. of them favor such legislation. Such unanimity of opinion upon great public questions is rare. The replies indicate a high order of capacity to grasp public questions on the part of this class of citizens, and suggest the thought that, if it could be made to replace the present grade of statesmanship pervading our legislative halls, the welfare of the country would be promoted.

In many of the replies the tariff question is discussed in connection with reciprocity, and in some of the answers the subsidizing of steamers carrying goods to foreign countries is also advocated. In general, the replies are direct and pointed. Most of them comprise some mention of the business with which the writers are speci-

ally connected, and of effects upon this business of previous tariff and reciprocity legislation. We quote some of the abstracts as fair samples of their general tone.

"The Passaic Mill Company, Paterson, N. J., manufacturers of structural steel and iron, and bridge builders (capital, $2,000,000; 1,000 persons employed; annual product, $2,000,000), say: 'Our foreign trade is naturally through commission houses. The removal or reduction of customs imposed by foreign nations upon our merchandise would restore to us a large business enjoyed a few years ago. By reason of better designs and more economical use of materials we can overcome a difference of twenty-five per cent. in the cost of materials used in construction. The facilities for production in our line of business are such as to produce double the consumption when all manufacturers in our line are producing to their full capacity, leaving fifty per cent. available for export. This is the principal cause of trouble among American manufacturers. The effect of the reciprocity treaties of 1890 was excellent, and the repeal disastrous.'

"Central Iron Works, Pittsburg, Pa., makers of iron and steel boiler plates, for structural work (capital, $500,000; 350 persons employed), say: 'We do not have foreign competitors. Our prices must be kept where they will not allow foreign products to come in. The total product in our line has increased in the past six years. Our domestic markets will not consume more product, and we ought to have foreign markets to go to. There was no result as to our product from the reciprocity treaties of their repeal, but we are in favor of general reciprocity legislation.'

"The Peerless Manufacturing Company of Louisville, Ky., manufacturers of fireplace furniture (capital, $200,000; 300 employees: value of annual product, $200,000), say: 'Have made direct efforts to extend the foreign trade by circulars and catalogues. A duty of thirty-five per cent. in Canada enables foreigners to steal our patents and make the goods cheaper than we can produce them. Our trade has increased sixty per cent. in the past six years. Our greatest competition is in Canada and England. We can compete with the world in quality, and, if foreign duty tariffs were reduced, in prices. The business could be increased seventy-five per cent., if every access could be had to foreign markets. Reciprocity treaties were favorable to our export trade, and their repeal was an injury so far as foreign goods were introduced into this country in competition. We heartily favor the reciprocity principle as applied to future legislation.'

"The Detroit Steel and Spring Company, Detroit, Mich., say: 'The value of reciprocity arrangements between our government and other nations would be felt indirectly rather than directly. We are one of the largest producers of railroad engine- and car-springs. This product is sold largely to railroads to whom we give freight business, and the advantage which we have over competitors in the trade lies in the fact that we are able to reciprocate for any preference or favor shown us. We are strongly in favor of reciprocity, believing that the benefit derived will be felt by everyone of our five hundred employees as well as by our stockholders. We are large producers of material used by the agricultural implement-makers, who are becoming exporters of considerable magnitude, so that any arrangement for the increase of their export business would be at once felt by our company. The value of reciprocity can hardly be estimated between nations.'"

Most of those who have not experienced any material benefit from previous reciprocity legislation favor it, nevertheless, on general principles. Those who have thus gone on record as favorable to the proposed legislation comprise a majority of the leading manufacturers in the United States.

Limitation as a Remedy for Social Evils.

PROF. JOHN CLARK RIDPATH, in *The Arena* for April, attributes a great part of "the distress of the modern world . . . to the fact that there is established in society and over man no salutary and accepted principles of limitation." "There is," he says, "no rational and welcome

doctrine as to the rules of restraint under which society and the organic life of man ought to be placed. Civilization seems thus far to have allowed its products to grow and run and clamber as they will across all fields, over all barriers, and up all heights, without regulation or wholesome pruning.

"If hitherto a limitation has been laid here and there upon the overgrowing exuberance of the organic life of man, it seems to have been laid in the wrong place, by the wrong hands, and with a wrong purpose. . . . The products of society, by the means adopted, have been warped and curtailed of their fair proportions, and man himself, even the thinking man, has come to dread the law of limitation, as if it were the suggestion of slavery or anarchism—according to the disposition of him who thinks it."

Professor Ridpath sees the "hints of limitation" both "in man and nature, . . . The natural limitations of life, however, do not much impede us; and if we are sound and sane they do not fret us at all." It is the misdirected and misplaced limitations that gall.

Professor Ridpath evidently thinks that a social state can exist in which the limitations are so laid that life in it may be far more easy and natural, contented and perfect, than is our present social life; and in a series of articles he proposes to discuss the limitatious which he thinks needful to secure this desirable result. The first part is devoted to landownership.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

*4734. Industrial Conditions and the Money Markets. Maurice L. Muhleman (Showing the effects of the financial crises and an unsound currency on the value of stocks and the development of industry). Eng Mag–April. 3500 w.

†4747. The Labor Party in Queensland. Anton Bertram (Historical and critical analysis of a great social movement which, though it is described as blind and incoherent, is compared with the independent labor party in the United Kingdom, and from this standpoint its achievements are startling. The article deals with conditions as well as results, with causes as well as effects, and is of great interest from beginning to end). Contemporary Rev–March. 9000 w.

†4749. Jesus the Demagogue. Walter Walsh (This paper is an able, just, and severe criticism of the modern tendency to regard Christ as a champion of democracy, and of the failure of this tendency to portray him as such, the result of the effort being rather to pose him as a demagogue. Instead of being a champion of the poor and oppressed, he is regarded as a savior of rich and poor alike, and his teachings were against the unrestrained selfishness of all classes of society. Instead of this the Christ of modern socialistic reform is a kind of sublimated Keir Hardie). Contemporary Rev–March. 5400 w.

4778. The British South Africa Company (Synopsis of the financial and material results of the operations of the company up to date). Bradstreet's–March 14. 900 w.

†4832. The Success of the So-called Popular Loan (The success, while gratifying, illustrates the principle that a popular loan draws from the gold resources of the country itself, whereas, if made through a syndicate, it could be stipulated that a portion of it should be imported). Banker's Mag–March. 1500 w.

†4833. Gold and Silver and the World's Money (An abstract, with voluminous tables, of a paper in the *Journal of the Royal Statistical Society*, by Mr. Lesley C. Probyn. The tables give estimates of money in countries where values are estimated in gold, in countries where values are estimated in silver, in countries where values are estimated in inconvertible paper, and in countries where values are estimated in monopoly rupees). Banker's Mag–March. 5000 w.

4860. The Labor Question in an English Foundry. R. A. Hadfield (A further contribution to the discussion of the relative merits of the system of payment by time, and payment by the piece, with other conclusions derived from experience in dealing with workmen, particularly in foundries). Am Mach–March 19. 2200 w.

4876. Responsibilities of Vocation. W. S. Penruddock (Discusses ancient and modern methods employed to prevent impositions by manufacturers upon customers, in the sale of manufactured articles). Age of St–March 14. 2000 w.

4881. A Railroad's Relief Department. L.W. Reilly (Believed to be the most complete account of the Baltimore & Ohio Relief Department and its results that has yet appeared). R R Gaz–March 20. Serial. 1st part. 2200 w.

4900. The Economic Aspect of the Transvaal Rebellion. C. (Reduction of gold output, diversion of the stream of emigration, and disturbance of commerce in which the mercantile interests are suffering, are topics discussed). Bradstreet's–March 21. 1500 w.

*4952. The Quarrel of the English-Speaking Peoples. Henry Norman (An exceedingly powerful plea for peace and a lucid portrayal of the folly of war for any cause between England and the United States. It is pointed out that

We supply copies of these articles. See introductory.

the United States is in no danger from British encroachments upon territory in the Western Hemisphere, but has seeds of mischief in her own borders which, unless attention of statesmen and patriots is soon directed to them, will be fruitful of sorrow for the great republic. It is intimated that the most terrific conflict between the "Haves" and the "Have-nots" will take place on American soil). Scrib Mag-April. 4000 w.

4961. The Statistics of Wages and the Cost of Living (The seventh and closing lecture in the special course on Social and Industrial Statistics by Carroll D. Wright, U S. Com. of Labor, at the School of Social Economics, Union Sq, New York. Abstract prepared by J. B. Walker). Sci Am Sup-March 28. 1000 w.

4968. Reciprocity Treaties (Summary of replies received by the Ways and Means Committee of the House of Representatives, to a circular of inquiry sent out to manufacturers touching the desirability of re-enacting a reciprocity provision, empowering the president to negotiate reciprocity treaties with foreign governments. The consensus of opinion thus obtained is favorable to such legislation). Ir Age-March 26. 5000 w.

4969. Conservative Influences in Labor Organizations (Editorial. Relates to a growing conservatism believed to exist in labor organizations, not as the result of timidity, but having root in the consciousness of a strength which is recognized and respected. This tendency is regarded as a very hopeful sign of the times). Ir Age-March 26. 1300 w.

*4970. Limitation as a Remedy. John Clark Ridpath (The present instability of human society and disturbance of peaceful living is regarded as the result of greed for property and prerogative for which practical limitations have not been established. This serial is intended to urge the importance of speedily establishing such limitations. The first part deals with land ownership as the real bottom of all the issues about which men are contending and drawing the sword). Arena-April. Serial. 1st part. 6000 w.

*4971. Planetary Freebooting and World Policies. Richard J. Hinton (The greed of European governments for new territory is characterized as no better than brigandism. In view of this insatiable greed, the true policy and duty of the United States are declared to be the enforcement of the Monroe doctrine, and the neutralization of both the Atlantic and Pacific oceans making them free world highways. Our national record should be unquenchable hostility to the policy of imperial piracy). Arena-April. 2800 w.

*4974. Deficiency of Revenue the Cause of Our Financial Ills. John Sherman (A critique of that portion of the president's annual message relating to the condition of our national finances, and of the views of Sec. Carlisle, which are in accord with those expressed by Pres. Cleveland). Forum-April. 5300 w.

*4976. Holland's Care for Its Poor. J. H. Gore (Describes the organization and working of two institutions specially designed for the benefit and protection of the poorer classes; viz., the Postal Savings' Bank, and the Loaning or Pawn Bank). Forum-April. 4000 w.

*5008. The Tariff in Legislation. James Albert Woodburn (A brief résumé of the legislative history of the tariff, merely presenting the landmarks and indicating their significance). Chau-April. 4000 w.

*5009. The Protection of Italian Emigrants in America. Luigi Bodio (Translated for the *Chautauquan* from the Italian *Nuova Antologia*. Suggestions as to what may be done by the Italian government to protect emigrants who go to ports in the United States, with some reference to other countries). Chau-April. 3000 w.

*5011. The Atlanta Exposition. Leonard Waldo (Historical account of this famous exposition. The first part describes the approaches and buildings). Engng-March 20. Serial. 1st part. 1600 w.

*5021. The Customs Tariff of Guatemala (List of alterations and modifications, as per a government decree reported by J. Frederick Roberts, British Chargé d'Affaires at Guatemala) Bd of Tr Jour-March. 2700 w.

*5022. Tariff Changes and Customs Regulations (Includes changes and modifications in Sweden, Germany, France, Indo-China, Belgium, Spain, Italy, Austria-Hungary, Japan, United States, Guatemala and British India). Bd of Tr Jour-March. 2800 w.

*5053. Engineering and Its Relation to the Labor Question. William Kent (Traces the relation between engineering and economic science, considering engineering as only an agent in increasing the wealth of mankind, and economic science only so far as it relates to the labor problem). Sib Jour of Engng-March. 2200 w.

5068. Labor's Value. W. S. Rogers (In the first part experience with different systems of wage paying is narrated. Incidentally gain-sharing and profit sharing are criticised). Mach-April. Serial. 1st part. 2400 w.

†5072. The Social Function of Wealth. Paul LeRoy Beaulieu (Translated from the *Revue des Deux Mondes*. Though the word "function" is used in the singular in the title it becomes plural in the treatment. Riches make their possessors leaders of men. Frederic Harrison's view that the first duty of capital is to take care of itself is adopted. The Christian maxim that the wealthy are the administrators of the poor is pronounced not wholly practicable from the human point of view; but the principle that the wealthy should be the economists of the poor is approved. One function of wealth is found in enterprises requiring patronage and remunerative philanthropy. But only income can be legitimately used. Gratuitous patronage of unremunerative works is another function. Still another is the foundation of public institutions). Pop Sci M-April. 2200 w.

*5074. Building Associations and Savings Banks (The competition of building associations with savings banks, the world over, as aids to economy is made the subject of comparison not only with the banks, but with other co-operative associations. Their increase in number and in membership is considered historically and philosophically, and the reasons for their prosperity

are found, not only in the profits which exceed those obtained by savings-bank depositors, but in the safety of the investments and the simplicity of their systems). Gunton's Mag–April. 3800 w.

*5075. A Full-Weight Silver Dollar (Starts with the assumptions that no solution of the silver question is feasible on the basis of silver monometallism, and that, if the fight is forced on monometallist lines, the single metal will be gold. The argument then deals with the use of silver with gold, as the only solution of the question, the system also to comprise parity of value between silver and gold dollars). Gunton's Mag–April. 1800 w.

*5076. Restoring American Ships (Predicts that the protectionist policy will be promptly inaugurated on the approaching election of a republican president and a thoroughly protectionist congress in 1896; and that this policy will then be extended to American shipping, substantially in accordance with the provisions of the bill introduced in the U. S. Senate by Senator Stephen B. Elkins, drawn by Mr Alex. R. Smith, editor of *Seaboard* The bill is commended for its simplicity and moderation, and it is believed by the author that its effect will be the restoration of commercial activity in our merchant marine, with great increase of prosperity in all our seaport towns). Gunton's Mag–April. 2300 w.

*5077. Economic Aspect of Large Trading (The large department stores are considered as an advance step in the progress of civilization, and are welcomed and justified as such. This great change in the economics of commerce is the result of an inherent tendency to concentration of effort, and therefore cannot be successfully resisted. The advantages of such concentration are treated at some length). Gunton's Mag–April. 2800 w.

*5078. American School of Political Philosophy. Thomas S. Blair (The possibility of founding such a school, its usefulness, and the tendency of such an institution to aid in the establishment of rule by the progress-securing class,—in other words, a government of the labor class). Gunton's Mag–April. 1400 w.

*5079. The Myth of Stock Watering (A critique upon the series of papers, written by Prof. Frank Parsons, and published in the *Arena*, on the Western Union Telegraph Co. Mr. Parsons is charged with a vast amount of diseased and emotional distress in depicting the expansion of the investments of the company named). Gunton's Mag–April. 1800 w.

*5080. German Socialism of To-day (An account of the rise and progress of German socialism and a résumé of the legislative proposals periodically brought forward by German socialists, only to be laughed at or rejected by overwhelming majorities). Gunton's Mag–April. 1500 w.

*5103. Bimetallism (Editorial comments upon a recent speech of the British Chancellor of the Exchequer in the course of a debate in the House of Commons, wherein he seeks to show that gold has not appreciated in value, as many economists of the opposite school assert). Jour of Gas Lgt–March 24. 800 w.

5130. Recent Constructions of the Interstate Law (Editorial review of recent decisions of the United States Supreme Court, by which the decisions of the lower federal courts are reversed). Bradstreet's–April 4. 1500 w.

*5158. A Legislative Remedy for Labor Disputes. Herbert Armitage Drake (The usual statement of the problem in which labor is regarded as antithetical to capital is considered an insufficient generalization for stricter and more scientific requirements. The writer therefore restates it in terms which define a laborer as one who works with his muscles and a capitalist as one who hires labor at a profit. The question is, in brief, whether the profits of a business shall or shall not affect the wages of those employed in it. The main issue is a fair wage, and this it is proposed to settle by a court of chancery, wherein disputes can be settled by either party who may wish to bring suit, and wherein standing of the parties would be as in other law courts. The scheme comprehends a compulsory fund contributed by labor organizations for defraying expenses of litigation, thus reducing all labor disputes to an issue of fact in a private suit between responsible parties). Am Mag of Civ–April. 5500 w.

*5159. Martyrs of Industry. E. D. McCreary (Calls attention to the great sacrifices of human life entailed in carrying on the great industries of modern civilization, and while it is admitted that the greater part of these casualties are results of unavoicable dangers, it is charged that reckless carelessness, selfish greed, and outright inhumanity remain significant factors in the annual list of injuries and deaths in the occupations necessary to meet the wants of mankind). Am Mag of Civ–April. 3000 w.

*5160. The Periodicity of Commercial Crises as Exemplified in the United States. E. V. Grabill (The lessons derived from commercial crises, and their periodicity are the utility of credit in the machinery of commerce; the full comprehension of the fact that all credit is founded upon confidence; the equally significant fact that commercial crises result from temporary impairment of confidence; and the importance of seeking to devise some system wherein there can be no means of destroying confidence. Historical sketches of the periodical commercial panics in the United States are given, in which loss of confidence was the result of unlimited speculation. In the author's opinion, the time will come when forcing up the prices of stocks and selling out under false pretences will be made a high crime). Am Mag of Civ–April. 3800 w.

5182. The Basis of Piece Work Systems (Editorial review of a paper by Mr. G. L. Potter, read before the Western Railway Club at its March meeting. Discusses vital points necessary to the success of the system, and expresses the opinion that piece work is to be the system of the future). Ry Rev–April 4. 1400 w.

†5325. The Reciprocity Will-o'-the-Wisp (Editorial on the foolishness of waiting for congress before making an effort to find customers in foreign markets). Ind Rub Wld–April 10. 1100 w.

MARINE ENGINEERING

Rates of Speed and Rates of Freight.

ONE of the most important of recent papers upon marine subjects, and intimately related to marine construction, was read by Mr. John Inglis before the Institution of Engineers and Shipbuilders in Scotland (Feb. 25). The object of this paper (of which we find an abstract in *The Engineer*, Feb. 28), as stated by the author, was "to show under what conditions of speed, cargo, and despatch it was possible for an ocean steamship company to pay the modest dividend of five per cent. to its shareholders."

For the convenient elucidation of the relation which possible profit bears to the conditions named, the author assumed "a ship of about ten thousand tons gross, differing from all other ships in possessing the remarkable property of a variable displacement on a given draught: that is to say, she alters her form and becomes finer and finer as the power of her engines and the desired rate of speed is increased; or otherwise, let there be an infinite number of such steamships differing from each other in form by very minute gradations. Then we are to suppose that the shipowner can choose any rate of speed he likes, without thereby affecting the volume of his business, his hand not being forced in any way by competitors; also, that he can always fill his ship with cargo to its utmost capacity, and that the number of passengers is the same, on the average, whatever time the ship takes over her voyage.

"Let us first take the case of a voyage out and home between two ports exactly three thousand miles apart, performed at average speeds varying from fifteen knots to twenty-one knots. Our steamer is assumed to have a displacement of eighteen thousand tons when adapted to the 15-knots rate, and, for every knot added to the mean speed at sea, six hundred tons is taken off the displacement."

These premises were followed by a demonstration of the time which could be saved on a voyage of the assumed length by increase of speed as follows. Increase from 10 to 20 knots effects a saving of 6¼ days; increase from 20 to 30 knots results in a further saving of 2 days and 2 hours; and increase from 30 to 40 knots a still further saving of only 25 hours. Of course, the higher speeds here named are impracticable, the maximum speed practicable for the assumed vessel being estimated by Mr. Inglis as 21 knots. The minimum average time a vessel must lie in port, added to the actual time of transit, determines the number of annual voyages she can make. But the cargo which can be carried also has a relation to the speed of running. The minimum time for remaining in port to discharge and put in cargo Mr. Inglis estimates to be 7 days, for such a quantity of cargo as can be carried at a speed of 19¼ knots.

From well-selected data Mr. Inglis then proceeds to compute the number of yearly voyages that can be made by a ship running at the last-named speed (deducting forty days for repairs), and the amount that she could earn on this basis, and, comparing these earnings with the earnings of vessels running at higher and lower speeds, he succeeds in showing that 19¼ knots is the speed affording maximum profit.

The diminution of profit at speeds higher than this is very rapid. Thus he shows that an increase of speed from 19¼ knots to 19.675 knots would wipe out all the profit. Reduction of stay in port from seven to four days would raise the speed corresponding to maximum profit to 20 knots.

These are only a few of the most important points made in this extremely able paper. The same method is applied to ships making longer voyages, one of the results arrived at being that a 12,000-mile voyage costs only 46 per cent. more than a 6,000-mile voyage.

The Pendulum Propeller.

AN exceedingly interesting paper upon this subject, by Mr. H. C. Vogt, of Copenhagen, is printed in *The Steamship* for January. The following abstract embodies the pith of this discussion, which results in the conclusion that this sort of propulsion, while superior to propulsion with oars (the latter being superior to the screw propeller for small boats), is only practicable for small vessels, or as an auxiliary propeller for small sailing vessels, say, up to 100 tons, for which, with an engine of 25 h. p. driven up to about 6 knots, it is superior to the usual propeller in every way.

Every observer of nature will doubtless acknowledge how far the devices of man in the domain of maritime propulsion are from the attainment of the results which, for instance, are obtained by swimming mammalia and fishes. It is said that a large fin-whale, with a displacement of about 30 tons, can swim at a speed of 50 knots an hour. In a case where one of these whales was harpooned from a cannon in a ship's bow, and the harpoon accidentally hooked itself fast in the cartilage of the back fin, without damaging the vital parts, the whale, by means of the strong chain fastened to the harpoon, drew a screw bark of 600 tons, with all sails set, against a fresh breeze, while at the same time its engine of 100 h. p. was backed with full power. It was said that this performance lasted for nearly two days at a speed of about 10 knots, after which the chain broke, and the animal went off at a tremendous speed. If the speed mentioned is correct, a power of 2,000 h. p., at least, was required for this performance. In the case of a smaller type, the dolphin, it is easier to obtain trustworthy information. From a fast steamer, running at a speed of 20 knots, it is often observed that the dolphin passes it with great ease, and its maximum speed is e timated to be 30 knots; while a Whitehead torpedo of about the same sectional area requires more than 30 h. p. for even a lower speed during a few minutes.

It is assumed, for good reasons, that the motion of a whale in swimming accords with that of a pendulum, and upon this assertion and other well-founded considerations a calculation of the horse power and speed of the fin-whale results in 1300 h. p. and a speed of 40 to 45 knots per hour.

The cut shows the construction and arrangement of the pendulum propeller as adapted to manual use. The want of adaptation of this system of propulsion to large vessels appears when the proper distribution of material, not much considered in the smaller propeller, is taken into account, and the question of higher speeds comes up. However, the simplicity of the machinery required and other advantages are thought to be sufficient to warrant further attention to the subject with reference to the propulsion of vessels within the limits named.

The propeller blade or rudder, *A*, is by the fork, *g*, firmly connected with the rudder stem, *a*, which, by means of the arm, *b*, and the spring, *c*, is connected with the cog-wheel, *H*, which, by means of the worm, *O*, can be turned round the tube, *r*, which also serves as a support for the rudder, *A*, the fork, *f*, rigidly secured on the rudder, *A*, being arranged to loosely embrace and turn on the tube, *r*. (The tube, *r*, also serves as bearings for the stem, *a*.) The piece, *T*, furnished with bearings for the worm, *O*, constitutes a rigid connection between the tube, *r*, and a horizontal main-shaft, *S*, which is provided with bearings, *L*, and a stuffing-box, *B*. On pulling one of the steering-lines, *u*, the worm, *O*, and consequently the cog-wheel, *H*, are rotated, and, by means of the spring, or springs, *c*, which connects the cog-wheel, *H*, with the rudder-post, *a*, the rudder, *A*, is turned. If, now, the main-shaft, *S* (Fig. 1), be put into an oscillating motion by the treadles, *F*, or by an engine (high pressure on one side and low pressure on the other), then the tube, *r*, with the rudder-stern, *a*, will swing like a pendulum in a plane at right angles to the plane of the drawing, and the pressure of the water on the rudder will cause it to oscillate about the axis of the post, *a*, first to one side and then to the other, in such a manner as to produce movements of the rudder similar to the strokes of the

tail of a fish, by means of which the vessel will be propelled. Since the rudder-post, *a*, is connected by the spring, *c*, to the cog-wheel, *H*, which is fixed in position, the amplitude of the oscillation of the rudder, *A*, about the axis of the post is dependent on the strength of the spring, *c*. In the accompanying illustration only one spring, *c*, is shown, but any desired number of springs may be employed, according to the size of the rudder, these springs being all arranged between the cog-wheel, *H*, and arms, *b*, fixed on the rudder-post, *a*. The springs employed for connecting the wheel, *H*, with the rudder-post, *a*, may, of course, be of various forms and construction. It is absolutely necessary, for the sake of efficiency, that the entire area of the blade, *A*, shall be on one side of the produced axis through *a*. The rudder-blade, *A*, will thus swing harmonically round two axes,—namely, like a pendulum round the axis of the main shaft, *S*,—and at the same time (regulated by the spring *c*), it will swing round the axis of the rudder-post, *a*. By pulling one of the steering-lines, *u*, during propulsion simultaneously with the pendulum-like oscillation of the rudder, the rudder can be caused, while moving in one direction about the axis of the shaft, *S*, to make angle with a plane at right angles to *S* greater than that made by the rudder with the same plane when moving in the opposite direction, and thus to effect the steering of the vessel, while still producing in it a motion ahead or astern, as before. By pulling one of the steering-lines, *u*, until the rudder is turned through an angle of more than 90°, motion ahead can be converted into motion astern, and *vice versa*; and, by turning the rudder through slightly less or slightly more than this angle, the steering of the vessel may be simultaneously affected when going astern. In order that the particular working teeth of the wheel, *H*, may be changed from time to time to equalize their wear, the wheel, *H*, may be fitted on a sleeve, *P*, so that it can be turned on the sleeve and then refixed thereon by means of screws, *h*.

Fig. 3.

Fig. 1.

Fig. 2.

Repairing a Broken Thrust Shaft at Sea.

THE steamship, *Mara*, on a voyage from Demerara to Trinidad in the spring of 1895, broke her thrust shaft at the second ring from forward. The conditions of weather, etc., under which the accident occurred, and the temporary repairs of

the shaft under most difficult circumstances, are the subject of an interesting and instructive narrative in *The Steamship* for March, of which we make the following abstract.

The ship was a cargo boat, and, like the majority of cargo boats, had not a superabundance of gear with which to cope with a break-down out of the ordinary run. The chief engineer knew this, and knew also that he would need a great many more tools than he had in repairing the shaft sufficientiy to take the ship into the nearest port, which he had resolved to do. In the first attempt, the third watch was started on cutting out slots in the thrust rings on either side of the fracture, wide enough and deep enough to take short lengths of a steel crowbar, 1½ by 2 in., which was the first and best thing to hand, as it was necessary to get a few turns out of the engines as soon as possible, to enable the drifting ship to clear the end of the island, which was getting dangerously near. To cut these slots, drills and chisels had to be dressed and tempered. When the slots were cut, the bars were fitted in, and were kept in position by an iron clamp (taken from the derrick boom), which was a fit on the shaft, held by two 1⅜-in. steel bolts. Steam being raised, the engines were tried; after a number of revolutions, the steel bolts broke, and the clamp and bars were rendered unfit for further use. On the broken gear being cleared away, four slots were cut in the rings, and two more crowbars and a steel vice were cut up for bars. These were fitted into position, and the spaces were filled with wood to the outer edge of the rings; a strong chain was then happed round over all, and wedged tight. On starting the engines again, in which great care had to be used, the bars, etc., carried away without scarcely moving the after shafting, owing to the poor quality of the material of which the bars were made.

It was at once resolved to try another method of repair. The coupling guard was taken off aft, and the bolts driven out of coupling. The rivets in the tunnel top were driven out, and the plate removed. It was growing very hot in the tunnel, adding greatly to the discomfort of the men. Gear was rigged in the hold to lift out the after end of the thrust shaft. This was accomplished, and the shaft was placed on end, with the coupling down, on the tunnel floor, though at great risk to the men working there, as the ship was rolling about in the trough of the sea. A slot had to be cut through the shaft at the fracture, this, and to enable the two ends to be operated on at the same time, being the reasons for taking the shaft adrift. The tools for this operation, every one of them, had to be made on the spot. Four 1½-in. drills were made from an old slice, and were tempered so finely that they drilled through 10¾ inches of shaft without regrinding, with utterly inexperienced men working the ratchet.

The slots being cut, the after end of the shaft was dropped into its place, and coupled up. The slots, coming together, made a section 8 by 10¾ by ½ in., to fill up. The only available material of this size was the end of the propeller spanner, and this was cut up in 10¾-in. lengths. It was cut up red-hot, and the pieces formed the keys. The quality of the metal was none of the best, and there was a flaw running right through the center (which was not seen until afterwards), where there was the greatest necessity for soundness. The largest key was driven into the slot with the large hammer, it being a very good fit, and the shaft was lapped again with chain. To enable this to be done, the ring nearest the fracture had to be cut away. The engines were started gently, and were run at 35 revolutions per minute on 50 lbs. of steam. The ship was doing about four knots per hour.

After running about twelve hours, the key broke through the center, where the flaw was discovered. The pieces cut from the small end of the spanner were forged into shape and fitted into the slot, fore and aft, and steel wedges were made to take up any slack that might have been caused by the first key. When this was finished, the engines were got under weigh again, but were run faster this time, to allow the thrust on the shafting to do something to-

wards keeping the keys tight. The ship was now doing about six knots per hour. The ship steamed into port seven days (lacking a few hours) after the shaft broke.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

4764. Inaccessible Maritime Lights. Elmer Laurence Corthell (Abstract of a paper promised in an early issue of Sci Am. Sup Gives a well illustrated account of the unique system of electric lights used in the entrance to N. Y. harbor). Sci Am–March 14 1500 w.

*4777. Repairing a Broken Thrust Shaft at Sea (An interesting and instructive narrative. Repairs accomplished under very difficult conditions). Steamship–March. 1200 w.

4779 New Orleans and Algiers Dry Dock (Particulars relating to the location of the new dry-dock, and the natural advantages which make it a judicious selection of site for the purpose of docking the United States war-ships of the larger size). Bradstreet's–March 14. 1200 w.

*4790. The Japanese Battle-Ship "Yashima" (General illustrated description. Details are promised in a future article. A plan and vertical section with dimensions are presented in this article). Engng–March 6. 2600 w.

*4792. The Belleville Boilers on H. M. S. "Sharpshooter." A. Dodgson (Brief description of the trials, tabulated data, and abstract of manœuvring trials). Engng–March 6. 400 w.

4894. Dry Docks in the Port of New York (Editorial. The position taken in the report of the board of consulting engineers to the effect that such docks should be a part of the dock system of New York is approved, and reasons for this view are given). Eng Rec–March 21. 800 w.

*4922. The Paddle Steamers Koningin Wilhelmina, Koningin Regentes, and Prins Hendrik (Illustrated detailed description of swift paddle steamers, built for the Zeeland Steamship Co., by the Fairfield Shipbuilding and Engineering Co., Limited, of Glasgow). Eng, Lond–March 13. 1300 w.

4972. The Danzenbaker Ice Boat (Illustrated description of a boat designed for breaking up ice obstructions to navigation on the Delaware river. The design contemplates the breaking up of the ice by a beak in the nature of a double mold-board plow, the point of which passes under the ice and whose inclined sides throw the broken ice away laterally in both directions). Shipbuilder–March 26. 900 w.

4973. Wells Engine in E. S. Renwick's Yacht (Illustrated description). Shipbuilder–March 26. 300 w.

4977. The Detroit Dry Dock Company's Plant (Brief but interesting illustrated description of a typical lake shipbuilding establishment). Sea–March 26. 1000 w.

4979. Triple-Expansion Engine of Yacht "Josephine" (Description with end elevation, side elevation and plan, showing all the principal features of the design). Am Mach–March 26. 300 w.

5035. The Naval Engineers' Reorganization Bill (Editorial review of the bill for reorganizing the Corps of U. S. Naval Engineers, introduced by Senator Squire and Representative Wilson. The main features of the bill are unqualifiedly approved). Eng Rec–March 28. 1800 w.

5086. P. A. B. Widener's New Steam Yacht Josephine (Illustrated description with side elevation and deck plans). Am Shipbuilder–April 2. 800 w.

*5176. Wreck Raising (Illustrated description of methods and appliances used by a leading English firm in salvage operations. The methods and appliances do not seem to differ greatly from those used in American waters). Engng–March 27. 4000 w.

*5177. Water-Tight Doors and Their Danger to Modern Fighting Ships. Charles Beresford (Paper read before the Institution of Naval Architects. Points out dangers attending present practice, and proposes remedies. These relate to the abolition of some of the water-tight doors, and the modification of others in respect to their size and their position in bulkheads). Engng–March 27. 3000 w.

*5178. Water-Tight Doors. N. Soliani (Paper read before the Institution of Naval Architects. Deals with dangers resulting from their use and suggests improvements in present methods. The danger is that such doors will be left open, and the reason they are so left is the difficulty in opening and shutting them. A method is proposed for the instantaneous opening or shutting of such doors by simply reversing an electric contact. Illustrated description of details is presented. Engng–March 27. 3000 w.

5215. Holland's Submarine Torpedo Boat (Illustrated description including a short biographical sketch of the inventor and designer—John P. Holland, of Newark, N. J.) Am Ship–April 9. 1800 w.

*5242. Engines and Boilers of the S. S. Aberdeen (Illustrated description). Eng, Lond–March 27. 700 w.

*5244. Water-Tube Boilers. J. Watt (Read at the 37th Session of the Inst. of Naval Architects. A study of defects in the type of boilers and of remedies for some of them, which are not inherent in the types, but result from faults in construction and setting). Eng, Lond–March 27. 2800 w.

*5257. Oil-in-Bulk Steamers (The advantages of shipping oil in bulk are in some measure neutralized by the difficulties met with in applying the method. These difficulties are explained, suggestions for possible improvement are presented). Eng's Gaz–April. 1000 w.

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

Entrance Requirements, Endowments, and Scholarships at Cornell University.

IN our April number we reviewed an editorial (*American Machinist*, Feb. 13) which criticised the gradual increase of educational requirements for admission to technical schools, naming Cornell University as one of the American schools in which this tendency is most to be regretted. The opinion was expressed that the intention of its honored founder seems likely to be thus defeated. Some other statements not palatable to the faculty of that institution were made.

To this criticism Professor R. H. Thurston made a strong, but courteous, replication, addressed to the editor of the paper named, and printed April 5. We will quote a portion of this reply,—which fills about six columns,—and briefly outline the rest. After characterizing the remarks with reference to Cornell University as unjust, Dr. Thurston adds:

"It is said that Cornell University 'aspires to the position of a State university.' The fact is that this university was founded in compliance with a contract with the general government, on the part of the State of New York, by which the latter, accepting the terms of the land grant bill of 1862, bound itself to 'found a college' for the purposes of that grant. This was done, and Cornell University is the State university or college so founded. Its name was given it in recognition of the fact that Mr. Ezra Cornell gave a half-million of dollars to the university and supplied the site.

"It is said that its endowment consists largely of 'public funds.' The fact is that the $6,000,000 endowment of Cornell University includes but about $400,000 of public funds, and that these funds came originally, not from New York, but from the United States government. The income from this source is $20,000 a year; from other sources, a half-million.

"It is said that Cornell's ideas are not carried into effect. The fact is that Cornell made the motto of the university: 'I would found an institution in which any man can find instruction in any study'—meaning, of course, college, not elementary, work,—and this motto has appeared in every issue of the official register and catalogue of the university from his time to the present; and every year, thanks to private beneficence, not public funds, finds it more effectively carried into action. I doubt if any institution in the world comes so near his ideal as does the university founded by him. Certainly none of the older and greater universities of our country do; and such work as Cornell is doing for the people is not even attempted by any university of which I have knowledge abroad. The chairman of the German commission, visiting this country in 1893 to study methods in education, writes me that he and his colleagues are urging on the Prussian and German governments the adoption of original and valuable features of our work. Yet it is—and probably always will be—true that, with added facilities, much more may be done.

"The statement is made that Cornell 'does little more than duplicate facilities for education which exist in ample degree without it.' My own judgment is that this, though true in a degree of every reputable institution,—all being founded with a common purpose, education,—is less true of Cornell than of any other that I know. Cornell possesses in its $500,000 worth of technical equipment more of practically valuable and useful equipment for the work that Cornell was most interested in than, I think, any other college in the world; and I doubt if its courses or its outfits are duplicated or fully paralleled by any college or university in existence—and I am tolerably familiar with what is done on both sides the Atlantic and in and around the Pacific. We have students from all the grand divisions of the earth, who come to us because of our peculiar

facilities in all departments of most importance to the people.

"It is asserted that 'the entrance examinations could not be better if they were intended to exclude students from the shops,' and that the founder's plans 'are forgotten.' This, of course, refers to the requirements, mainly, in our 'technical courses.' It is perfectly true, as we are proud—not to admit, but—to assert, that our entrance requirements to the regular courses in mechanical engineering, for example, are exceptionally — some of our friends th nk extraordinarily—high. They do not, however, exclude men from the shops; and we have, I am positive, many more men from the shops to-day than we had ten years ago, when the university and Sibley College assumed to teach elementary school work. The fact is that, given the right spirit, the young man in the shop will prepare himself for any course that is deemed by him to be likely to promote his ultimate success, even though he is compelled to study the higher mathematics; at least, that is our experience. Men from the shops still stand, with us, in many instances, at or near the head of the class."

Professor Thurston declares that the "high standard set for those who desire the diploma of the university" excludes no one "competent to do college work," and that want of social position closes no course of study to any applicant. Any one can at will choose and pursue any study for which he is found prepared. "Any deserving and ambitious young man may even enter the university, if twenty-one years of age, without an examination, if he can show any member of the faculty that he is of the right stripe, is ready to enter any work offered in the university, and can find enough to do to keep him busy fifteen hours a week at least. We have appointed hundreds of such men, and they often work their way up into regular courses, and finally graduate."

Without being able to fortify the impression by statistics, Dr. Thurston believes the number of shop-men in Cornell to be larger than it was ten years ago, and to be annually increasing. He asserts that "nowhere have the industrial classes a freer path," and that, "outside the courses leading to degrees, with its provision for special students, for optional courses," and for a great variety of courses of instruction, the university follows Cornell's motto in a manner that "commands the commendation and admiration of every intelligent man familiar with its work." That comparatively few take "elementary or half-way work" is the result of preference on the part of students themselves, and not of any restriction imposed by the institution. The summer schools afford facilities for the study of nearly all subjects that cannot properly be included in a college curriculum.

The existence of the aristocratic tendency among students, as charged by the *American Machinist*, is positively denied. It is asserted, on the contrary, that "there is nowhere illustrated a more perfectly democratic spirit." Cornell is declared to have been "maligned by those who should be its best friends. . . . Rich men's sons are welcome, and poor men's sons cordially received and cared for; but no one knows or cares which is which in the class-room or on the Campus."

Men who desire to help themselves financially are afforded opportunities in various ways for earning money. Among other excellent provisions for helping along poor students is the rule that "a desirable student is never turned away. His fees are omitted, if he is unable to pay." The number of those who are compelled to accept any of these provisions is small, as the majority of men are able to work their way through without such aid, and prefer to do so. Cases of men living on the merest pittance per week, yet retaining the respect of their fellow students, are instanced. In conclusion, it is asserted that all changes in the institution, since its organization, have been in the direction of more and better work, and of increased usefulness. That it has departed somewhat "from the humbler toward the higher field" is admitted; but this has been compelled by "State burdens changing circumstances, and excess of members seeking costly instruction."

The editor of *American Machinist* replies that the central idea in the editorial which called forth the defence of Cornell by Professor Thurston "was that scholastic admission-requirements had become so high as to shut out those who had not previously attended school without interruption." That readers may judge for themselves whether this view is or is not justified, it prints, as pertinent to the controversy, the requirements for admission to Cornell.

The Massachusetts Inspection and License Law.

How this law has operated during the past year, and the possibilities it opens for licensing incompetents should it remain in its present form, are editorially considered in *Lord's Magazine* for March.

This law requires that all boilers not periodically inspected by companies that have complied with all the laws of the commonwealth shall be reported to the State inspection department. This has given an impulse to the business of boiler inspection and insurance companies. Boiler owners seem generally to prefer to deal with such companies rather than with the State department. A general improvement in the condition of boilers has thus far resulted from the act. Such owners as have not dealt with the authorized inspection and insurance companies can be compelled by the State inspection department to use safer boilers, if the boilers they now use are pronounced dangerous by the State inspectors. Another good effect is the enforcement of better supervision for boilers used in schools and other public buildings for heating purposes only. How urgently such improvement was needed is illustrated by the following account of an occurrence in a school not specifically named.

"The janitor in the case noted was in the habit of leaving a good fire in the furnace on or before nine o'clock in the morning, and the steam pressure high enough to keep the rooms thoroughly warm until twelve o'clock, when he would give the boiler his attention again. One day, in the early part of the spring, the boiler was so left, and, the day turning out warmer than the janitor expected, the teachers in the building found it necessary to shut off the steam from the radiators. This naturally resulted in bottling up the steam in the boiler and main pipe, with no outlet for it. When the janitor returned, according to his usual custom, about twelve o'clock, he noticed a heavy pressure on the boiler. How high this pressure was he could not tell, as the gage was not large enough to register it. The safety-valve was also found stuck. Instead of reducing the pressure, as he should, the janitor pried the safety-valve from its seat with an iron rod. As a result, the steam rushed out, filling the cellar and the rest of the building with a tremendous roar, frightening the scholars so badly that they rushed from the building in a panic. Fortunately, none were seriously injured. Such a condition of affairs is not only possible, but decidedly probable, in any building where the boiler is so long neglected. The law has no provision, stating just how long an attendant shall be absent from the building; yet such length of absence is nothing short of neglect, and the janitor who is not in the habit of taking better care of his boilers would probably not be granted a license until he was found to be more competent."

So much with reference to boiler inspection. The license law has also been a means of great improvement, although it is shown to have grave defects. One of these is the want of provision for crediting an engineer for the number of years he has successfully operated a plant, making an examination necessary to qualification for a license to operate a similar plant. As the law stands, he can be licensed to run the same plant without examination, but not any other plant just like it, which is obviously absurd.

The system of classification has been much objected to also. As the law stands, 150 h. p. is the limit for second-class licenses, though no reason can be assigned why a man competent to run such an engine should not also be qualified to run a 500-h. p. engine. The following quotation will show the absurdity of a classification

based upon the capacity of engines. "An engineer might be perfectly capable, from his experience, to handle 1000 h. p. of plain non-condensing engines in any plant, but be utterly at sea if placed in charge of a 125-h. p. plant with four valve engines or those of condensing type; just what grade of license such an engineer would be entitled to is a matter of conjecture."

It is further shown that the scheme of examinations is so devised that from the study of books alone candidates for licenses may fit themselves to pass and attain a first-class license without any practical experience whatever. The law also fails to specify not only the attention that should be given to boilers, but also that which should be given engines, the frequent lack of which is too well known. Engineers often absent themselves from their posts, and too frequently, when on the spot, neglect obvious duties. Some penalty should follow such neglect. On the whole, the law is approved, but the criticisms suggest lines upon which it could be amended to advantage.

The Thoroughfare Steam Jacket.

MR. W. H. BOOTH, a frequent and able contributor to the *American Machinist*, having challenged a statement previously made by Mr. Charles T. Porter (widely known in both America and Europe as one of the foremost engineers in the United States), the latter gentleman makes a courteous and instructive reply in the columns of the same paper (March 19).

Under the title above given, he first compliments Mr. Booth's ability as a writer upon a wide range of mechanical subjects, and then replies to the challenge of his statement that a body of steam more or less enveloping a cylinder, yet contained in space forming part of the channel for passage of steam from the boiler to the interior of the cylinder, is not a steam jacket. To a body of steam of this kind, as distinguished from what Mr. Porter would have no hesitation in calling a steam jacket, he now applies the expressive and convenient term "thoroughfare steam jackets," and, in reply to Mr. Booth, says:

"Mr. Booth has asked me to explain why I made the statement that 'the so-called jackets, through which the steam passes on its way to the cylinder, are not jackets at all.' This it will afford me pleasure to do, and I hope I may be able to do it in such a manner that Mr. Booth and all who may read the explanation shall be satisfied with it. The statement is, I admit, rather dogmatic in form, perhaps unnecessarily so, and to some it may on this account seem offensive. To such I beg to tender my apology for my apparent rudeness, but I expressed in fewest words exactly what I meant to say and am now ready to prove.

"But first I want to speak of the satisfaction with which I read Mr. Booth's remarks on the effect of air in the jacket, impairing and even ruining its efficiency. This subject was not mentioned in my article in the *American Machinist*, because that was a one-idea article, directed to an entirely different point. My view of the subject is, however, on record, as follows, on page 147 of the last volume of the Transactions of the American Society of Mechanical Engineers: 'I have long been impressed with the conviction that the efficiency of the steam jacket must be seriously impaired by the accumulation of air, which is abandoned by the steam as it is condensed, and which there is commonly no way to get rid of.'"

The method employed for ridding radiators of air—an air-valve at the point the farthest practicable from the point of admission—Mr. Porter regards as probably not adequate for a steam jacket. Of a design for a vertical tandem compound engine, shown and described by him in the paper above referred to, and which engine is now being constructed in triple-expansion form, he says:

"I have provided a current through the cylinder heads and through every part of the jackets, into a reheater, in which the air is finally separated and discharged. I rely on this current for carrying with it all the air, on account of its sweeping nature and its downward direction. The cylinder heads, by the way, I regard as forming the most useful part of the jacket.

"I cheerfully admit that, of all means

for freeing a jacket from air, a current of steam sweeping through on its way to the cylinder must be the most effective. The jacket, however, as everyone will agree, is not made for the purpose of being kept free of air. Its office is to reduce to a minimum, and, if possible, to prevent altogether, the condensation of the steam as it enters the cylinder. We seek to get rid of air only because it interferes with the performance of this function.

"Any argument on this subject must assume the steam to arrive at the cylinder entirely dry. It is obviously absurd to expect the jacket to prevent, or even to diminish materially, initial cylinder condensation, when the steam brings water with it to chill the internal surfaces by its evaporation during the exhaust. This chill extends to the jacket, causing the steam in it to be condensed to no purpose. In cases of wet steam, the plan of Hick, Hargreaves & Co., described by Mr. Booth, of diverting the jacket from its legitimate use to serve as a separator, seems a very good one. The chamber inclosing the cylinder is made to answer some purpose, instead of being quite useless—only it should be called by its right name. The fact that boilers do commonly deliver more or less water with the steam does not affect the question. Dry steam is the fundamental requisite for economy, and, moreover, it can always be had. It must be assumed in any discussion of the action of the jacket.

"In every steam engine, superheating being left out of the account, at each stroke of the piston water must appear somewhere. Work is done. An equivalent number of units of heat disappear. These are supplied by the steam. A portion of it has lost its heat of vaporization. At the end of each stroke the water thus formed is either in the cylinder or in the jacket, —most commonly partly in each. That in the jacket is under the boiler pressure and has the boiler temperature, and can be returned to the boiler to have its heat of vaporization restored. That in the cylinder is thrown away with the exhaust, and this is not the worst of it. This water also has its heat of vaporization restored, and the cylinder does it. All the internal surfaces of cylinder, heads, piston, passages, and valves are chilled to the extent necessary to effect the re-evaporation of this water during the exhaust. At the moment of the next admission these surfaces are dry and cold. The first work of the entering steam is to heat them up again, for they must have the full boiler temperature, or the pressure cannot be in the cylinder. This the steam does by condensing in a dew all over them, and now at the end of the stroke there is twice as much water in the cylinder to be evaporated. The sole function of the jacket is to prevent this cylinder condensation, which must follow the evaporation during the exhaust.

"Now, the so called jackets, through which the steam passes on its way to the cylinder, perform another function besides freeing themselves of air; they condense a portion of the entering steam, and sweep that along into the cylinder, to be evaporated precisely as if it had come from the boiler, thus defeating entirely the object of the jacket. This form of jacket was, so far as I know, first used in this country by Mr. Corliss, after he introduced his vertical boiler, which superheats the steam considerably. Copying him, some makers of his engines, as well as others, now use this construction—without employing superheated steam."

Topical Discussions.

TOPICAL discussions in engineering societies form one of their most valuable features. There is nothing that elucidates engineering subjects more than the free expression of opinion, wherein the results of practical experience and theoretical considerations have equal place. The interest and importance of such discussions is more and more recognized as time advances, and many societies now pre-arrange for the discussion of topics announced in advance of regular meetings. This organizes such debates into a system, and renders them exceedingly effective. It increases the attendance at meetings, and maintains a vital interest in the

proceedings of the societies.

Conspicuous among the societies which have promoted topical discussions is the Western Society of Engineers, which has commenced the regular issue of a well-edited bi-monthly journal. As a sample of the thoroughness with which this sort of work is conducted in this society, the following excerpts are made from its March circular to members and others.

"The subject selected is that of 'Steel Forgings.' All discussions sent to the society will be carefully edited and published in the *Journal*. We enclose herewith a list of questions which have been prepared in regard to 'Steel Forgings.' We will appreciate very much receiving from you a discussion on this subject. The questions are submitted to you merely as suggestions. We wish to obtain for publication the fullest and most practical information possible. Your discussion should be in the hands of the committee not later than April 30. Will you kindly favor us with such information as you can on this subject? The discussion, when published, will be sent to all persons who contribute any material. We are promised a very full discussion from a number of manufacturers and engineers who are in possession of valuable information.

"(1) Are there any advantages of steel over wrought-iron forgings? If so, what are they? (2) Are forgings made from open-hearth steel superior to those made from bessemer steel? If so, why? (3) Is there any difference, for practical uses, between forgings made from basic and acid steel? (4) What methods have been found to give most satisfactory results in producing solid and homogeneous ingots from which forgings are to be made? (5) Should steel forgings be made under separate and distinct methods of treatment from wrought-iron forgings? (6) What are the relative merits of hammered forgings and those forged under press? (7) Should there be any treatment of forgings subsequent to forging and before machining? If so, what? (8) What is the effect of simple annealing of forgings, and also of tempering and subsequent annealings? (9) What is the best form of specification for drop-hammer rods, stamp stems, and other similar forgings which are subjected to shock and vibrations?"

The field covered by these questions is one of broad interest to all who use iron and steel as materials for manufacture; and, if the subject be as ably handled by participants in the discussion as was the subject of hydraulic cements in the meetings of this society, we may anticipate much interesting information to result.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

*4731. Modern Machine-Shop Economics. Horace L. Arnold (Pointing out the considerations that should govern shop locations). Eng Mag-April. 3700 w.

4750. The Sand Blast Apparatus for Cleaning Castings. Fred C. Brooksbank (An interesting paper setting forth at length the uses of the sand blast in the treatment of castings, its advantages as compared with pickling, some of the disadvantages of pickling, and other matter of interest to iron founders). Ir Age-March 12. 5000 w.

4753. Making Large Brass Castings. C. Vickers (Practical hints upon the subject). Am Mach-March 12. 900 w.

4914. Making a Large Kettle in Loam (Illustrates and describes the molding and casting of kettles weighing 18000 lbs., several of which have recently been produced in a western iron foundry. A good study in loam practice). Foundry-March. 700 w.

4918. The Foundry Foreman. H. R. Ramp (A plea for higher salaries for competent foremen, in the interest of foundry owners). Foundry-March. 800 w.

4939. Sheave Wheel with Wrought Iron Arms. W. H. Osborn (Illustrated description of the moulding and casting of sheave wheels with wrought iron arms and of diameters ten feet and upwards). Ir Tr Rev-March 19. 700 w.

4978. Electric Welding in England. John Marsden (Letter reprinted from the *Mechanical World* (England) presenting an interesting account of electric welding as practiced in a shop doing a wide variety of machine forging and repairing). Am Mach-March 26. 1000 w.

*5044. Electric Power Transmission in Workshops. Daniel Adamson (The bulk of this paper is devoted to a description of, and remarks upon applications of electric power in a large workshop in England. Though thus restricted, useful hints upon such applications are

We supply copies of these articles. See introductory.

presented). Prac Eng–March 20. 3000 w.

5066. Cleaning Castings by Hydrofluoric Acid. R. Moldenke (Hydrofluoric acid is recommended as a substitute for sulphuric acid as a pickle for castings, and its superior advantages are set forth. It actively dissolves the silica in the scale, and only attacks the iron in strong pickles). Age of St–March 28. 1800 w.

5069. A Few of the Snares of Pattern Making. John M. Richardson (A plain practical discussion. Hints towards the avoidance of mistakes in pattern shop and foundry). Mach–April. 1800 w

5216. Lathe for Boring and Turning Sixteen-Inch Guns at Watervliet Arsenal (Illustrated detailed description of a lathe weighing 280 tons, 138 ft. long, whose head stock alone weighs 52 tons, and each carriage 18 tons. The 16-in. guns turned in this lathe weigh 142.5 tons and are 50 ft. long). Am Mach–April 9. 5400 w.

5217. The Practice of the Ordnance Department, U. S. A., in Doing Lathe Work on Heavy Guns. Anthony Victorin (Illustrated detailed description). Am Mach–April 9. 5200 w.

Steam Engineering.

4752. Water-Hammer in a Steam Pipe—The Cause and Its Cure. William J. Williams (Account of the rupture of an iron body stop valve in a 3 inch wrought iron pipe, and of a case of severe water-hammering cured by a simple change in the boiler connection of the steam-pipe. Sketches illustrate the wrong way and the right way). Am Mach–March 12. 800 w.

4820. Water Purification for Steam. John M'Naull Wilson (Read before the Northwestern Electrical Assn. Recommending the purification of water outside of the boiler, in tanks, whereby all scale forming solids are precipitated and soft, clean water only supplied to the boiler). Elec Rev–March 18. 3800 w.

4861. Superheating. W. H. Booth (A historical, theoretical, and practical paper). Am Mach–March 19. 1600 w.

4863. The Thoroughfare Steam Jacket. Charles T. Porter (Reply to a criticism by Mr. W. H. Booth of views previously expressed by the author, relating to the advantages of steam jacketing). Am Mach–March 19. 1100 w.

4865. Impossible Guarantees (A cause of great annoyance connected with the operation of steam plants is discussed). Eng Rec–March 14. 1000 w.

4871. The Corliss High-Service Low-Duty Pumping Engine of the Providence Water-Works (Illustrated description of an engine of novel and peculiar design, built for pumping directly into high-service mains). Eng Rec–March 14. 200 w.

*5052. Determination of the Moisture in Steam. R. C. Carpenter (This paper points out errors likely to be made in the use of calorimeters, and endeavors to show that if proper allowances be made for losses, correct results in the determination of moisture in steam may be obtained by the calorimetric method). Sib Jour of Engng–March. 4000 w.

*5107. Angular Advance. O. H. R. (A critique on a method often employed in explanation of the meaning and effect of angular advance in cases where link-motion reversing gear is used. A correction of the method is proposed and explained). Loc Engng–April. 1200 w.

5119. Cooling Water for Condensing Purposes. W. H. Booth (Description of various methods of cooling water for repeated use, in condensing exhaust steam, with illustrated description of an evaporation condenser). Am Mach–April 2. 1200 w.

5121. Latent Heat (Editorial. Starting with the assertion that the term "latent heat" is very inadequately comprehended, this article, in the form of a reply to a correspondent, gives an explanation of the term, and the relation of latent heat to sensible heat). Am Mach–April 2. 1600 w.

5125. The Strength of Boiler Flues (A summary of the results of tests made at the Imperial Docks at Danzig in the six years from 1887 to 1892. A very thorough and important study). R R Gaz–April 3. 2000 w.

†5168. Experimental Determination of the Influence of Back Pressure on the Economy of a Surface Condensing Engine with Independent Vacuum Pump. Percy Allan, Everett Bruen, Frederick K. Vreeland (Illustrated description of apparatus and method and an account of test, with diagrams and tabulated data). Stevens In–April. 6000 w.

*5187. The Economics of Propulsion in the Modern Steamship. R. L. Weighton (Lecture delivered at the Marine Engineers' Institute, South Shields, on the 9th of Dec. 1895). Prac Eng–March 27. Serial. 1st part. 3000 w.

5222. Fly-Wheel Governors. George T. Hanchett (Fly-wheel governors and some of the principles of their design). Elect Wld–April 11. 1600 w.

Miscellany.

*4730. The Present Status of Aerial Navigation Ill. Octave Chanute (Showing the progress made in aerial navigation during the last four years, and the comparative importance of studying the flight of the sailing birds rather than that of the flapping birds). Eng Mag–April. 3200 w.

4754. Rope-Driving Practice. W. H. Booth (Hints derived from English practice. Discusses the superiority of cotton for power transmitting ropes). Am Mach–March 12. 1500 w.

4823. The Limits and Possibilities of the Gas Engine. Sidney A. Reeve (A critique on Mr. George Richmond's article on the same subject published in *Engineering Magazine* for Feb. Mr Reeve, while conceding the value and interest of Mr. Richmond's paper, yet joins issue with him in several points). Pro Age–March 16. 3700 w.

4824. The Measurement of Cyclically Varying Temperature. Henry F. W. Burstall (This paper embodies results of attempts at measuring temperatures reached in the cylinder of a gas engine in progress since 1892. A very important

paper, with numerous diagrams and tables). Pro Age-March 16. 4500 w.

*4837 The Storage and Explosion of Compressed Gaseous Mixtures (Report of committee of British Board of Trade appointed to inquire into causes of this class of explosions and precautions necessary to be adopted). Jour Gas Lgt-March 10. 2200 w.

*4838. Researches on the Combustion of Illuminating Gas in Cooled Flames and Gas Motors. Dr. F. Haber and A. Weber (Account of researches carried out in the Chemical Tech. Inst., at Carlsruhe, at the instance of Dr. H. Bunte). Jour Gas Lgt-March 10. Serial. 1st part. 2800 w.

4856. The Explosion in the Oil Engine. Samuel Rodman, Jr. (A critique of views previously published in the same journal by Mr. Tecumseh Swift). Am Mach-March 19. 900 w.

4857. The Method of Projection That Is Actually Used. Louis Rouillion (Results of inquiries made by a committee of the Art Teachers' Assn. Letters of inquiry were addressed to technical schools, teachers, colleges, authors, and leading mechanical firms. The third angle method of projection is recommended as the simplest and most used). Am Mach-March 19. 1000 w.

4858. Measuring a Steel Tape. Walter Gribben (A good illustrated description of a job quite out of the usual run of machine shop work). Am Mach-March 19. 1000 w.

4888. Fittings and Joints for High Pressure Piping. John Platt (Discusses various methods of making tight joints in pipes with illustrated descriptions of joints which have proved eminently serviceable and durable; also presents a table of proposed standard flanges for hydraulic packing for the adoption of which an effort is now being made). Eng News-March 19. 1100 w.

*4908. Mechanical Connections. Francis B. Crocker (The following connections are considered: chain and sprocket wheel; magnetic belting; shafting; shaft couplings; friction clutches; magnetic clutches; pulleys; toothed friction; and other gearing). Elec Pow-March 1. 4800 w.

4915. Manipulation and Deterioration of Cast Iron. H. J. Grof (Characteristics of cast iron, and the scientific and frugal principles of melting it in cupolas). Foundry-March. 1200 w.

4916. The Mobility of Molecules of Cast Iron. Alexander E. Outerbridge, Jr. (An exceedingly interesting paper, in which the general belief that repeated shocks make cast iron brittle is disproved by results of about 1000 tests, showing that within certain limits cast iron is strengthened by subjection to shocks). Foundry-March. 2800 w.

4917. How Can a Founder Determine the Value of New Devices and Fluxes which Are Recommended to Him (A plea for systematic testing of foundry materials and appliances). Foundry-March. 900 w.

*4921. Mechanical Engineers' Estimating (Changed conditions have rendered new and more elaborate methods necessary. These methods are editorially considered). Eng, Lond -March 13. 1800 w.

*4927. Official Report on the American Horseless Carriage Trials (Complete text of the report of the judges of the competitive trials at Chicago). Eng, Lond-March 13. 7000 w.

4980. The Tests of Motocycles at Chicago (Summary of a report of a committee of examination, with tabulated data). Am Mach-March 26. 550 w.

*5027. Automatic Firing Guns. Hiram Stevens Maxim (The first part is devoted entirely to the history of revolving fire arms). Ind & Ir-March 20. Serial. 1st part. 2200 w.

*5051. A New Method of Governing Water Wheels. Harvey D. Williams (Illustrated description of a new method whereby the speed is corrected by energy that would otherwise be wasted because of incorrect speed). Sibley Jour of Engng-March. 2000 w.

†5062. Automobile Vehicles. Pedro G. Salom, with discussion (After a brief historical retrospect, the bulk of the paper is devoted to a description of the Morris and Salom Electrobat). Jour Fr Inst-April. 6800 w.

5067 Some Early Milling Machines (Historical notes relating to the first beginnings of milling machine construction). Mach-April. 1500 w.

†5082. A Study of the Causes Which Lead to Breakage of Gears and Pinions. Charles F. Uebelacker (The first part deals with the gearing of electric motors on street cars, in which the conditions are severe. Diagrams and formulæ are presented, but the discussion is in the main practical in character). St Ry Jour-April. Serial. 1st part. 1800 w.

5088. Niagara Falls Hydraulic Power Plant (Interesting illustrated description). Sci Am-April 4. 1600 w.

5118. A Stone Planer (Illustrated detailed description of construction and operation). Am Mach-April 2. 1000 w.

5120. Power Calculation for a Traveling Crane. Charles I. Griffin (Formula for computing is presented, based on the principle that the power required for bridge traverse will be practically that required to overcome journal friction after the speed has once been established. The power necessary for starting is separately dealt with, as is also the power for effecting the hoist). Am Mach-April 2. 1300 w.

5148. Artificial Refrigeration. George Richmond (A popular lecture delivered at Cooper Inst., March 1, 1896, under the auspices of the N. A. S. E. Power-April. 4500 w.

5151. Compressed Air. W. L. Saunders (The subject will be treated under three heads.—production,—transmission,—and use. The first number treats of the relation between heat produced in the act of compression and the mechanical energy expended in the act). Compressed Air-March. Serial. 1st part. 1700 w.

5224. The Gas Engine and Its Electric Applications. Charles Macdonald (Read before the Chicago Electrical Assn. A brief review of the history and development of the gas engine of the past and present). Elec-April 8. 4500 w.

MINING & METALLURGY

The Walrand-Legenisel Process.

IN a paper read before the American Institute of Mining Engineers (Pittsburg meeting), Mr. H. L. Hollis describes this interesting modification of bessemer practice, along with the later improvements in continental works. *The Iron Age* (Mar. 5) abstracts as follows:

"Briefly stated, the Walrand-Legenisel process is an addition to the bessemer operation, with the object of obtaining quiet and more fluid steel and consequently sound castings and ingots. This is achieved by adding ferrosilicon at approximately the time of flame-drop in the ordinary bessemer operation and making an after blow. The high calorific power of silicon is well known, and the rapid combustion of it immediately before pouring raises the temperature of the steel most noticeably, and what is further, finishes the steel-making operation by the combustion of silicon to a solid (slag) instead of carbon to a gas. The high temperature thus obtained and the consequent fluidity of the steel is well shown by the very small and intricate castings, running down to a fraction of a pound in weight, which are regularly made; but perhaps the best indication of the heat of the steel is shown by the fact that as small charges as six hundred pounds have been blown successfully for several years at Paris, and often the charge poured entirely into small work, taking from fifteen to twenty-five minutes, without a sign of skull in the ladles.

"The details of practice vary considerably at the different works where this process is employed, but the features in common are briefly these: the vessels employed are the usual type of bottom-blown bessemer converters. These receive the pig iron in the ordinary way, and the blowing is continued until about the time of flame-drop, when the vessel is turned down and ferrosilicon (containing from ten to twelve per cent. silicon) is added. An afterblow is then made, the time for terminating which varies at the different works. After this, ferromanganese, or spiegel, is added to the vessel for recarbonizing, and the steel poured into large ladles on cranes or small hand-ladles, according to the nature of the work. The blowing is generally controlled by aid of the spectroscope.

"A mention of the differences in practice may be of interest. At the works of Eugene Legenisel in Paris there are two converters, one of 1200 pounds' and one of 600 pounds' capacity. The sprues and heads and all steel scrap are melted with the pig iron in the cupola, and every cupola charge consists, after the first one or two heats, of about 80 per cent. pig and 20 per cent. steel scrap. The ferrosilicon and spiegel additions are melted in small and very ingeniously arranged cupolas and added to the converter by means of ladles. In blowing the converter is turned down the first time just short of flame-drop, so as to leave enough carbon to act as an index in the spectrum of the afterblow. The silicon in the steel very seldom exceeds 0.05 per cent., and often runs down as low as 0.02 per cent. A very large part of the small work is cast in green sand. At the works of the Messrs. Schneider, Le Creuzot, there is one 1,500-pound converter. The steel scrap is added directly to the converter, and the ferrosilicon and ferromanganese heated red, but not molten. The spectroscope is used to control the blowing, as at Paris, but the vessel is turned down younger in the afterblow, and the aim is to have 0.20 per cent. silicon in the steel. At the works at Hagen, Westphalia, there are two 1,200-pound converters. The blowing here is continued to flame-drop for the first turning down, and the afterblow regulated more by time and the general appearance of the flame than by the spectroscope. The additions are melted in crucibles, and the small work is poured from crucibles. The Potter & Hollis Foundry Company, Chicago, have had for several months one 1,500-pound converter in operation, and another

one is now being added. The steel scrap is added entirely to the cupola mixture, and the ferrosilicon and spiegel added molten. The blowing is controlled practically the same as at Paris. The most important change in practice is in the blast pressure. On the continent very high pressures are employed,—up to thirty pounds per square inch,—while at Chicago not over ten pounds has been used. Melting the additions in crucibles, as at Hagen, and in small cupolas, as at Paris, has been tried, and the former certainly is more satisfactory. The pin bottom, as used at Hagen, and also the usual tuyere bottom, have been tried, and it is, perhaps, too early to say which gives the better results. The steel made by this process is satisfactory in every respect. Entirely sound castings of any size, up to the capacity of the vessel, as well as ingots, are obtained, and the steel shows high physical tests.

"A word in regard to the silicon in this steel. While it is possible to run the silicon down for regular practice as low as 0.05 per cent., it is found that nothing is gained by doing this, so far as castings are concerned. By increasing the silicon (even as high as 0.50 per cent.) the tensile strength is raised very much without appreciably lowering the elongation. Tests for magnetic permeability have been made with this steel containing over 0.30 per cent. carbon and with manganese above 1 per cent., which have given the very best results. While it is not the intention of the writer to theorize, it would seem that the very high casting temperature, together with the freedom from gas, resulted in physical conditions in the steel which modified the influence of the chemical constituents, as generally formulated."

Gold Mining in Russia.

GOLD occurs both in quartz and in alluvial deposits. The former were treated with little profit when the attempt was made as far back as 1779, but the former were worked to the extent of about a ton of gold per year. The methods of concentration, according to *Machinery* (London, March 15), are on the principle of the old-fashioned tom. The simpler form consists of a series of two troughs fourteen feet long and eighteen inches wide, one emptying into the other. The rich sands are thrown into the upper one under a stream of water, and raked and stirred, the coarse pebbles being retained by a perforated plate at the end and the fine material running into the second trough. This is provided with cross slats on the bottom, which catches the mud and through which the gold sinks and is thus retained. There are, however, two more complicated forms employed, illustrated in Fig. 1 and Fig. 2. The first is thus described:

"The kind in common use is figured in our illustration, which, in operating, will give employment to about eight men. The sieve, or grating, firmly fixed, is 3½ feet square. The tye with which the fine sand is carried by an inclined plane is 16 feet long by 2½ feet wide, with an inclination

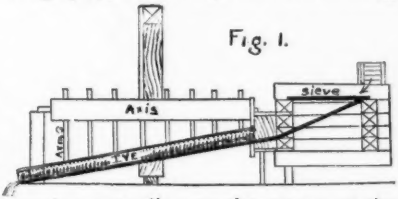


Fig. 1.

varying according to the nature of the sand, and having its bottom curved in the arc of a circle.

"Above the tye is a wooden axis, turning in gudgeons, and having fixed to it beneath as many arms as the tye has compartments, each of which is fitted with a number of claws or blunt knives, and by an alternating motion, given to the axis by two men holding a line attached to it, the claws pass backward and forward in an arc, and keep the sediment in continual agitation. The partitions in the bottom are ribs, 2 inches high and 2½ inches wide, held by screw bolts and nuts, and can be removed at intervals for washing out the concentrated auriferous sand, the more frequently as the sands are richer in gold. This has been more fully described by the great authority on gold mining, Mr. Warington Smyth.

"Another Russian gold-washing apparatus is that shown by Fig. 2. This may

be familiar to the few who know the district, but it cannot fail to interest all who are in any way connected practically or otherwise in search of the precious metal. This machine has been commented upon favorably by Captain Razguildeyew. To make our illustrations clear the description is as follows: A is an upper ring, across which are suspended the iron harrows, a; it performs a rotary motion by means of the two lever arms, g and h, on the tramway, n, o. b is the grinding floor or sieve, which is slightly concave in the centre, and is formed of plates of cast-iron joined together. c is the lower stage of the machinery, on which the disintegrated sand can fall from the sieve; then the sand, borne by water, falls on the washing

apparatus will wash 10,000 puds—of 36 pounds—in twenty-four hours, and requires about six horses.

"The purest gold which is found in a native state always contains a percentage of silver, sometimes in such proportions as to change the appearance of the mass, making it white instead of yellow. Gold is found in combination with copper, and by this admixture proves that gold, whether in quartz or in alluvial deposits, was so placed by precipitation or evaporation from solution. In the auriferous sands of the Urals—which, though called sandy, are but very slightly sandy clays—platinum generally accompanies the gold. This is not often met with otherwise than with this metal."

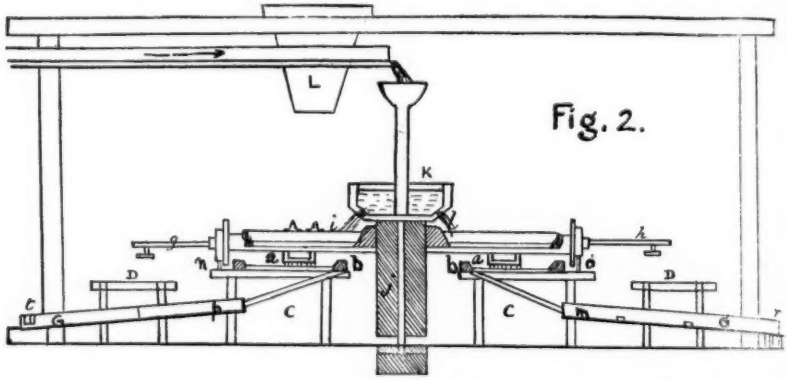


Fig. 2.

tables, m, n, o, p, which affect the concentration of the auriferous matters. q, r, s, t are reservoirs for the dirty water and sand. From these the sands are finally thrown away or rewashed on a table. D is the horsewalk, e the opening for exit of pebbles or gravel not shown, f table for washing pebbles—which is usually placed under the sieve. The water from this table passes over another one shown at G, on which finally the minutest particles of gold are deposited. K is the general receptacle or box of cast-iron fixed to the iron spindle, j; the water from this reservoir is spread by the iron pipes, i, l, arranged so as to wet the sands. This same water passes over the washing tables, and thence into the settling reservoirs. L is the sludge channel for the sands. This

Hydraulic mining has been found impracticable. Quartz veins are worked which contain eight pennyweights of gold to the ton; the ore is crushed, and then treated as in the case of alluvial deposits.

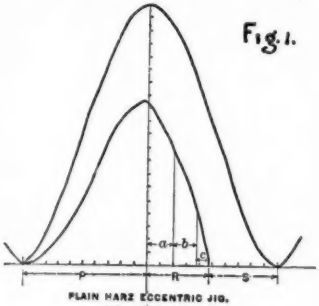
The Cycle of the Plunger Jig.

THE author of this paper, Prof. R. H. Richards, contributed to the American Institute of Mining Engineers (Pittsburg meeting) a very valuable addition to their proceedings when he gave them the results of his experiments in this little-understood field. After describing the apparatus by means of which he secured the curves representing the movement of the water, tailings, and ore, and giving the diagrams and tabulated results, he says:

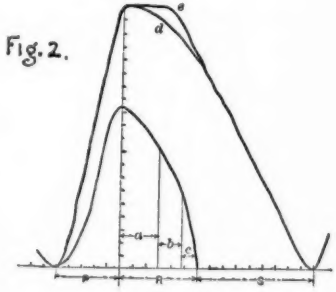
"It will be seen, upon inspection of the

diagrams, that the water-curve, W, and the quartz-curve, R, rise to their highest points and then descend, but that the quartz always gets down before the water. We may say that there are three periods: (1) pulsion; (2) return; and (3) repose, or suction.

"To aid in this discussion, two ideal diagrams (Figs. 1 and 2)have been drawn. In Fig. 2 two top curves are given; the flat top, *e*, and the pointed top, *d*. A few of the diagrams indicate that the flat top



PLAIN HARZ ECCENTRIC JIG.
Ideal Diagram.



ACCELERATED JIG.
Ideal Diagram.

is normal; but the remaining accelerated-jig curves speak for the pointed top.

"The three periods named may be further discussed as follows:

"Period I.—Pulsion, P, or upward movement. The water- and quartz-curves diverge, because the water is moving up faster than the quartz. Here the law of hindered settling is acting to bring the coarse galena below the quartz, and the fine galena adjacent to, and in equilibrium with, the proper size of quartz.

"Period II.—Return downwards, R, which is divided into three periods:

"(*a*) A moment when the quartz- and water-curves are converging, because the water is moving down faster than the quartz. Here the fine grains of galena acquire their maximum velocity downwards before the coarse grains of quartz; and hence Rittinger's law of acceleration is probably at work, helping the fine galena to get below the coarse quartz.

"(*b*) A moment when the two lines of quartz and water are parallel,—that is, a moment of relative idleness as to separation.

"(*c*) A moment when the curves of quartz and water are diverging. The sand is falling faster than the water; hence the law of hindered settling is again at work.

"Period III.—Suction, S. Here the sand reposes upon the sieve. The water-curve, W, is converging rapidly towards the horizontal quartz-line, R; therefore, the water is passing down through the sand at a high rate of speed. Here suction comes in to draw downwards through the interstices the small particles of galena which the law of hindered-settling has placed adjacent to, and in equilibrium with, the larger particles of quartz.

"Looking at the jigs by classes, we see that the eccentric jigs invariably spend more time upon pulsion than the accelerated jigs. Is it not fair to conclude that the eccentric jigs are better adapted for treating sands which require the most pulsion? Such sands are the sized products from the trommel and the first spigot of the hydraulic classifier.

"On the other hand, may not the long-protracted mild suction of the accelerated jig be the best adapted to the treatment of such products as required primarily suction for their separation,—for example, the second spigot and following spigots of the hydraulic classifier?

"The two extreme suggestions arising from a contemplation of these curves are:

"1. That on closely-sized products an accelerated jig should be used, run *backwards*, to lengthen out the pulsion-period, which is the only period that does any work; and

"2. That the accelerated jig should be run *forward* on the spigot-products of the hydraulic separator, to increase the period of suction.

"There are in the way of the first suggestion two difficulties, either of which may cancel the advantage: first, the violent downward motion of the quick return will tend to 'blind up' the sieve; and secondly, the same action will tend to pulverize a soft mineral like galena.

"I am not ignorant of the wide difference between theoretical speculation and commercial operation, in which it often happens that some small, unnoticed need of practice undoes a beautiful theory, rendering it unsuited for adoption. The suggestions offered in this paper are therefore put forward simply as ideas which appear to have merit and to be worthy of further study and test."

Balance-Sheet of a South African Mine.

WE take this abstract from the *Mining and Scientific Press* (Jan. 11) for the valuable data it contains relating to interesting mines:

"The following is the official report of the directors of the Wemmer mine at Johannesburg, South Africa, for the month of October. The Wemmer is what is called a 'main reef mine'; its capital is £55,000; its market value, £550,000; it is six years in existence; its present monthly profit is about £11,000. The figures below are of interest to the American miner:

EXPENDITURE.

Mining account.				£5,725	1	6
Sorting account.	£495	12	11			
Less stone sold.	188	5	6			
				307	7	5
Water service from pan to mine				5	6	3
Total.....	10,985 tons....			6,037	15	2
Reduction expenses—						
Crushing ore..	1,158	3	5			
Concentration.	230	10	6			
Tailings wheel.	14	4	11			
Electric lighting.....	33	4	11			
Breaking rock at main shaft.	126	5	7			
Transportation of ore to mill.	217	10	9			
Total.....	7,052 tons.....			1,780	0	1
General charges—						
Licenses, medical expenses, directors' fees, sanitary expenses, accident and fire insurance, salaries and charges.....	7,052 tons			£ 413	12	0
Development redemption...	7,052 "...			2,467	10	0
Cyanid works—						
Treating	4,375 "...			765	3	6
Total expenditure.....				11,464	1	3
Profit for month...				11,057	12	10
Grand total.....				22,521	14	1

REVENUE.

Gold account—						
4098.63 ounces bullion realized.				14,954	6	1
Cyanid works—1,585 05 ounces bullion realized.....				5,433	11	4
Concentrates estimated for October production.....	2,499	0	0			
Less deficit on September production....	365	3	4			
				2,133	16	9
Total income.....				22,521	14	1
Total amount spent on development, including 423 feet of driving and sinking.....				1,933	4	5

CAPITAL ACCOUNT.

New incline main shaft.....	375	15	6
Buildings and general improvements...	1,062	1	0
Total cost of improvements.	1,437	16	6

MILLING RESULT FOR OCTOBER.

Stamps at work.....	50 stamps.
Working time.....	30 days.
Tons crushed.....	7,052 tons.
Tons crushed per head per day....	4.70 tons.
Bar gold extracted	4,098.63 ozs.
Yield per ton crushed.....	11.62 dwts.
Tailings treated.....	4,375 tons.
Bullion returned.....	1,585.05 ozs.
Concentrates caught.....	160 tons.
Assay value.....	5 ozs. 6 dwts.

"The total yield per ton, including extraction from tailings and concentrates, is 18.78 dwts. fine gold."

Oregon Nickel Deposits.

IN a paper recently read before the Colorado Scientific Society Mr. W. L. Austin describes the nickel veins near Riddle's, Josephine county, Oregon. These are noteworthy as being the only deposits of

nickel ore in the United States, so far as known, with the exception of the Nevada occurrences, which appear to be of commercial importance, and which are now of special interest in view of the demand for nickel steel for armor and other uses. The original discovery of this locality is said to have been made so far back as 1864, and at different times several persons and companies have operated in the district, for the most part unsuccessfully because of metallurgical ignorance. Numerous open cuts, short tunnels, and shallow shafts have been made, demonstrating that the ore (a silicate) occurs in large quantities; while the extent of the veins is very considerable, the nickeliferous croppings at the summit of Piney mountain being in places eighty feet wide. About three thousand tons of ore have been mined, said to average five per cent. nickel, but some running as high as fifteen and twenty per cent. Mr. Austin thinks that it would be difficult to get any quantity of it that would average above eight per cent. from the present surface workings, the surface ore being decomposed and much of the nickel leached out. Thus far no serious metallurgical work has been attempted on the spot. A few carloads have been shipped away for experimental purposes. One of the mining companies had intended to concentrate the ores and smelt, but the low specific gravity of the ore (2.20 to 2.58) and its very friable character seem to preclude the use of wet concentration. Experiments have been made in ordinary lead-smelting furnaces, which were not at all suited to the high temperatures required; also in steel-melting crucibles, unavailable on account of the small quantities handled. Simple fusion in cupolas is not a practical solution of the metallurgical problem, because of the preponderating amount of gangue which it is necessary to flux off and the large quantity of fuel used. Mr. Austin notes the possibility of matting the ore with the help of nickeliferous pyrrhotite (from the neighborhood), to be afterwards blown in manhès converters. A 3 per cent. ore has been concentrated, however, by heating the crushed ore with a reducing agent to produce a magnetic combination, which is afterward extracted with a magnetic separator. Mr. W. Q. Brown, who applied this treatment, has also experimented in the line of converting the nickel into chlorid by roasting with salt and then leaching. Besides the methods mentioned, there are others which, as Mr. Austin says, perhaps lend themselves better to the object in view. If the ore is in sufficient quantity and of fair tenor, as the assay seems to indicate, the metallurgical difficulties will no doubt be overcome, as has been the case in New Caledonia and Canada.

These experiments illustrate some of the difficult metallurgic problems which often arise in the development of new mining properties.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

Metallurgy.

4751. The Development of Open Hearth Steel (This happy look into the future shows that 62 open-hearth furnaces, ranging from 5 to 50 tons capacity, have been built since 1894, and claims many advantages for these furnaces over the Bessemer converters). Ir Age-March 12. 900 w.

4768. Tests of Cast Steel Projectiles (A description of some cast steel, armor-piercing projectiles made by Messrs. Isaac G. Johnson & Co., that have shown remarkable results in government trials). R R Gaz-March 13. 900 w.

4780. How to Make Iron. R. W. Raymond (Lines read at the Pittsburg banquet of the Am. Inst. of Min. Engs. An odd combination of a grimy handed industry and poetic fervor in which the point made seems to be that members of the A. I. M. E. should be consulted in all things metallurgical). Eng & Min Jour-March 14. 1200 w.

*4789. The Works of Boël Brothers, La Louvière, Belgium. Ill. (The Bessemer steel is "poled" with an elm pole and the top of the ingot mold is fastened down with a single bent wedge. There are other novel features not usual in American practice). Ir & Coal Trs Rev-March 6. 600 w.

4852. Comparative Costs of Producing Pig Iron (New figures presenting the subject in a new light, from the 1894 Report of the Bureau of Industrial Statistics of Penna. (Ir Age-March 19. 700 w.

We supply copies of these articles. See introductory.

4853. New Jersey Fire Clays. Charles Ferry (A condemnation of the "bung" method usually employed in testing the refractory properties of clays). Ir Age-March 19. 1200 w.

4960. The History of Electric Heating Applied to Metallurgy. Frederic P. Dewey (Read before the Washington section of the Amer. Chem. Soc.). Elec Rev-March 25. Serial. 1st part. 2200 w.

4986. Analyses of Pig Irons Used for Different Purposes (Discussion on "Physics of Cast Iron" before the A. I. M. E. The composition is given for five uses to which foundry iron is put). Eng News-March 26. 700 w.

*5019. Investigations on the Influence of Low Temperatures on Iron and Steel. M. Rudeloff (Extract from "Mittheilungen aus den Koeniglichen Technsichen Versuchsanstalten zu Berlin." The author gives the results of previous tests and also those recently conducted at the Imperial Navy Yard at Wilhelmshafen). Mech Wld, Lond-March 20. 1500 w.

*5028. The Lixiviation of Silver Ores. John H Clemes (A paper read before the Inst. of Civ. Engs. The process employed at the Yedras mines in Mexico is described). Ind & Ir-March 20. 1500 w.

*5029. Mining and Treatment of Copper Ore at Tharsis, Spain. C. F. Courtney (A paper read before the Inst. of Civ. Engs. in which the method of mining and treatment are briefly described). Ind & Ir-March 20. 1200 w.

*5030. Tin Smelting at Pulo Brani, Singapore. John McKillop and T. Flower Ellis (A paper read before the Inst. of Civil Engs. It describes in an interesting manner the first successful attempt at competition with Chinese smelters of the Straits Trading Co). Ind & Ir-March 20. 1200 w.

*5045. The Bowling Iron and Steel Works (Description of a Yorkshire iron works started in 1780, but now compelled to shut down permanently). Ir & St Trs Jour-March 14. 700 w.

5046. The Effect of Coke Oven Construction on Coke. R. M. Atwater (A paper read before the Society of Engineers of Western Penna., setting forth the advantages of the Semet Solvay retort coke oven). Ir Tr Rev-March 26. 2500 w.

*5094. The Invention of the Bessemer Process (An interesting letter from Sir Henry Bessemer, replying to a paper read by Mr. J. D. Weeks before the Am. Inst. of Min. Engs. He shows how Mr. Kelly, who it is claimed conceived the present Bessemer process, never produced any successful results and therefore invented nothing). Ir & St Trs Jour-March 21. 5000 w.

5102. Sulphur in Mild Steel. F. E. Thompson (The writer first briefly reviews previous investigations, and then shows the treatment of sulphur in the basic converter and in the basic open hearth furnace, giving a large number of analyses, tests, and other data). Ir Age-April 2. 3500 w.

5146. Matte Smelting. W. L. Austin (A general discussion containing a few new facts and numerous comments upon Mr. Herbert Lang's book on "Matte Smelting"). Min & Sci Pr-March 28. 3000 w.

†5171. Review of the Present Status of Iron Analyses. Gus C. Henning (Lecture delivered before the American Chemical Society, New York). Stevens' In-April. 3800 w.

*5179. The Invention of the Bessemer Process (Editorial discussing Bessemer's claim to the honor of inventing the process that goes by his name, in opposition to the assertion of the president of the American Institute of Engineers that he was not the original inventor,—the real inventor being an American named Kelly). Engng-March 27. 3000 w.

*5239. The Efficiencies of Gas Producers. Charles Frewen Jenkin (A paper read before the Inst. of Civ. Engs., being a historical summary of the various types of gas producers with the results of tests of cold gas efficiency shown in diagrams). Col Guard-March 27. Serial. 1st part. 2800 w.

*5250. The Causes of Mysterious Fractures in the Steel Used by Marine Engineers as Revealed by the Microscope. A. E. Seaton (Paper read at the 37th session of the Inst. of Naval Architects upon the results of an investigation of a broken shaft, concluding that the practice of boring out a shaft is a good one. Microscopic sections are shown and the report of an expert presented). Ir & St Tr Jour-March 28. 2000 w.

*5251. The Manufacture of Naval Forgings (Remarks upon American practice in high requirement forgings, giving some examples from the Bethlehem Iron Co). Ir & Coal Trs Rev-March 27. 1800 w.

*5252. Present and Prospective Ore Requirements of German Blast-Furnaces. E. Schrödter (Paper read before the *Verein deutscher Eisenhüttenleute*. The condition of the industry in each of the five districts in Germany is described, giving production and area of each). Ir & Coal Trs Rev-March 27. 2200 w.

†5254. The Demand and Supply of Iron in Japan. (Discussion upon an article in the *Japan Daily Mail*, by the ex-director of the Japanese Mining Bureau). Ir & Coal Trs Rev-March 27. 1000 w.

5255. The Direct Production of Iron and Steel. Carl Otto (Translated from *Stahl und Eissen*). Am Mfr & Ir Wld-March 20. 2500 w.

5256. The Baudoux and Gobbe Small Tank (Description of an innovation in the shape of a small capacity glass-melting furnace for the manufacture of window glass). Am Mfr & Ir Wld-March 20. 1300 w.

Mining.

4762. Gasoline Engines and Borax Mines (The successful application of these engines to an arid region and their adaptability to trying conditions are described. There is a cut of a direct connected air compressor, and a view of a borax mine). Min & Sci Pr-March 7. 800 w.

4763. The World's Greatest Gold Lode. Dan De Quille (A discourse upon the bigness of California gold prospects). Min & Sci Pr–March 7. 3500 w.

4781. The Labor Question in the Transvaal Mines. Pierre Leroy-Beaulieu (Translated and abstracted from letter in *L'Economiste Français*. The article shows the labor market in a rather demoralized condition at present). Eng & Min Jour–March 14. 1400 w.

*4788. Lessening the Danger of Blasting in Fiery Pits. Franz Brzezowski (Abstracted from *Oesterreichische Zeitschrift für Bergund Hüttenwessen*. The safety measures at present at disposal are central fire cartridges, moss stemming, good cartridge covers, safety explosives, removal of coal dust by spraying, and finally skilled workmen). Col Guard. March 6. 1400 w.

4814. Georgia Marbles. William M. Brewer (The writer refers to several quarries and illustrates three of them). Tradesman–March 15. 600 w.

*4828. Some African Gold and Diamond Stealers (A very interesting article from the *South African Review* showing ingenious methods employed by professional robbers to unlawfully procure gold and diamonds). Aust Min Stand–Feb. 6. 1600 w.

*4829. The Victorian Alluvial Goldfield (A map of about thirty miles of alluvial district having the roads, claims, rivers and hills located with explanation in the text). Aust Min Stand–Feb. 6. 2400 w.

*4834. Anthracite Mining at the South Wilkes-Barre Colliery. W. W. Jones (Geological features, methods of mining, ventilating and drainage, etc., at an anthracite colliery of large capacity. Numerous cuts illustrate the geological formation, method of mining, ventilation, transportation, cars, and cages. It is a description of a typical plant). Col Eng–March. 8600 w.

*4848. Mining Permanency in New South Wales. W. H. J. Slee (Are our mineral deposits nearly exhausted and worked out? Does mining pay? These questions were answered by the chief inspector of mines, at the recent mining conference at Sydney). Aust Min Stand–Feb. 13. 1100 w.

*4850. Stones from Norway and Sweden. Herr Lund (This interesting article is illustrated by views from various granite quarries and gives one a good idea of the commercial and engineering sides of the industry). Stone–March. Serial. 1st part. 1200 w.

4873. A Dry Placer Machine (Illustrated description). Min & Sci Pr–March 14. 400 w.

4874. The Mining of Mica (A brief description of the method employed in North Carolina). Min & Sci Pr–March 14. 500 w.

4899. The Auriferous Gravels of the Upper Columbia River. Frank L. Nason (Describes the actual conditions under which the gold occurs and the method of working the placers and prospecting. Eng & Min Jour–March 21. 2400 w.

*4911. Statistics of Coal Production and Consumption (Tabular statements are presented giving the statistics of the British, Russian, Swedish, German, Belgian and French coal industries). Col Guard–March 13. 2500 w.

*4912. The Use of Safety Explosives in German Mines (Official report to the British Home Office of two of H. M. mine inspectors delegated to be present at the experiments made in Westphalia. The article contains a great deal of additional information on German mines). Col Guard–March 13. 3500 w.

*4913. Reports on the Blackwell Colliery Explosion (An investigation into the method of working the mine, and the cause of the explosion. Coal dust caused the disaster, being ignited by a blast). Col Guard–March 13. 3200 w.

4929. Unexplored Gold Regions. Dan De Quille, in *Salt Lake Tribune* (The article touches upon the fields of Thibet, Siberia, Mongolia, British Guiana and Venezuela). Min Ind and Rev–March 19. 2200 w.

*4934. The Extension of the Main Reef Westward of the Farm Witpoortje. Mr. Draper (Read before the Geol. Soc. of South Africa. An attempt at a geological explanation of the Witwatersrand formations). Min Jour–March 14. 4000 w.

*5015. Electric Driving for Works. Daniel Adamson (Paper read before the Manchester Assn. of Engineers. The application of electricity to various kinds of engineering work is ably discussed). Col Guard–March 20. 2300 w.

*5016. Separate Ventilation in Fiery Mines. Bergrath J. J. Mayer (The author treats of the ventilation of preliminary headings lying out of the direct line of the main air supply). Col Guard–March 20. 1300 w.

*5043. Russian Gold Mines (An extremely interesting article upon the railway projects and the methods used at the mines. Every mining man would do well to read the description of the novel method of concentration used). Mach, Lond–March 15. 3000 w.

5095. Nova Scotia Gypsum (The industry is briefly described in a general way, and the shipments given in quantity and value from 1890 to 1895; when 133,300 tons were sent out). Can Min Rev–March. 800 w.

5096. Ontario as a Mining Country. Dr. A. P. Coleman (A brief synopsis of the extent of the industry in the various mineral substances which the province produces). Can Min Rev–March. 3500 w.

5097. The Financial Aspect of Mining. J. H. Chewitt (An examination into the various causes which determine whether a mine will pay or not). Can Min Rev–March. 1500 w.

5098. Improvements in the Dressing of Gold Ores. F. Hille (This excellent paper describes the various up to date methods used in the concentration of fine material and gives illustrations of the Belharz, Spitzlutte percussion table, Laszlo amalgamator and Krupp's amalgamating table). Can Min Rev–March. 6000 w.

We supply copies of these articles. See introductory.

5099. Compressed Air at Sydney Mines, Cape Breton. R. H. Brown (The results of experience in a coal mine are given with description of plant employed). Can Min Rev–March. 1000 w.

5100. Experience with Air Compressing at Drummond Colliery, N. S. Charles Fergie (The underground pumps were driven by compressed air from a compressor located at the surface. The advantages are discussed). Can Min Rev–March. 1500 w.

5101. A Newfoundland Iron Deposit. R. E. Chambers (Paper read before the Min. Soc. of Nova Scotia. The deposits are located on Great Belle Island in Conception Bay and have been worked. The ore contains from 54 to 59% metallic iron). Ir Age–April 2. 1200 w.

5145. Gold Mining in Rhodesia. W. T. St. Auburn (An interesting description of methods and conditions in a South African gold district). Min & Sci Pr–March 28. 2700 w.

†5156. Problems of the Transvaal. Karl Blind (An article protesting against the policy of England in "grabbing" South African territory). N Amer Rev–April. 6500 w.

†5157. Gold Mining Activity in Colorado. T. A. Rickard (A very entertaining article showing the vicissitudes of Creede and Cripple Creek and the influences upon which the mining activity of the district depended). N Amer Rev–April. 3000 w.

*5236. Continuous and Automatic Sample-Taking of Air in Colliery Workings. Paul Petit (From a communication to the Société de l'Industrie Minérale, by the manager of the Saint-Etienne collieries. The apparatus used is described and illustrated by a diagram). Col Guard–March 27. 2000 w.

*5237. Horizontal Driving with the Aid of Congelation. M. F. Schmidt (Two methods were described before the Société de l'Industrie Minérale of Saint Etienne. One where the freezing pipeswere inserted around the periphery of the section, the other where the whole heading was frozen solid. A cut illustrates each method). Col Guard–March 27. 1600 w.

*5240. British Coal in France (In a Foreign Office Report, dated Feb. 13, 1896, Consul O'Neill, of Rouen, makes some observations with reference to the consumption of British coal in France, and the effect which the new railway tariffs are likely to have upon the trade, with colonial statistics). Col Guard–March 27. 1500 w.

*5253. The Mineral Resources and Railways of Cuba (A most interesting paper showing how the natural resources have been neglected and the general lack of interest in improvements). Ir & Coal Trs Rev–March 27. 1300 w.

Miscellany.

*4736. The Relative Value of Different Coals. H. M. Chance (Showing the qualities that give coal thermal value, and the methods and importance of testing them). Eng Mag–April. 3300 w.

*4737. Determining the Value of an Iron Mine. Nelson P. Hulst (A consideration, in the order of their importance, of the factors that influence the commercial worth of iron mines). Eng Mag–April. 3800 w.

4803. Notes on the Cerrillos Coal Field. John J. Stevenson (Abstract of a paper read before the N. Y. Academy of Sciences. Interesting description of a coal field in New Mexico, about 25 miles south from Santa Fé). Science–March 13. 1800 w.

*4830. An Age of Gold (An entertaining article from the *Manchester Sunday Chronicle* which says that this period will probably be known before the end of the century as the age of gold). Aust Min Stand–Feb. 6. 1300 w.

*4920. Cordite (This explosive was adopted by the British Government for the ordnance. Its properties are described at length). Eng, Lond–March 13. 2000 w.

*5017. The Recovery of Tar and Ammonia from Blast Furnace Gases. Andrew Gillespie (A paper read before the Inst. of Engineers and Shipbuilders, in Scotland). Col Guard–March 20. 3000 w.

*5018. The Estimation of Carbonic Acid in Flue Gases. A. H. Sexton (A paper read before the West of Scotland Iron and Steel Institute). Col Guard–March 20. 1200 w.

†5033. The Manufacture of Calcium Carbide. J. T. Morehead and G. de Chalmot (A full exposition of the processes used, with cuts of furnaces. Numerous experimental results are given). Jour Am Chem Soc–April. 5800 w.

†5034. Särnström's Method of Determining Manganese in Iron Ores. C. T. Mixer and H. W. Du Bois (This volumetric method gives results in about half an hour, and checks very closely with gravimetric methods). Jour Am Chem Soc–April. 1400 w.

5090. Experiments on the Action of Flameless Explosives upon Fire Damp and Coal Dust (The experiments conducted by the North of England Inst. of Min. & Mech. Engs. show that no commercial explosive is entirely flameless. The article contains an excellent illustration showing the apparatus employed). Sci Am Sup–April 4. 1000 w.

5164. Quarterly List of Tin Plate Works (An able compilation showing such progress in this industry in the United States as to give force to the prediction, given in editorial remarks and conclusions, that soon all that will remain to the foreign tin plate makers of their once magnificent American trade, will be the re-exporting business). Met Work–April 4. 2500 w.

†5165. An Occurrence of Free Gold in Granite. George P. Merrill (Description of a specimen in the national museum). Am Jour of Sci–April. 800 w.

*5238. Tertiary Pitch Coal at Wirtatobel, near Bergenz. Dr. Wilhelm von Gümbel, *Oesterreichische Zeitschrift fur Berg und Hüttenwesen* (Description of some curious coal deposits at the northern foot of the Alps, in the molasse formation). Col Guard–March 27. 1200 w.

We supply copies of these articles. See introductory.

MUNICIPAL ENGINEERING

Pipe Distribution and Water-Supply for Fire Service.

MR. WILLIAM PERRY, writing in *The Canadian Engineer*, favors a gravity system for fire service whenever this can be obtained within a reasonable limit of cost. Such a system is always ready for service when required, an advantage not always secured by pumping directly into mains. While the latter system gives satisfactory service in many cases, Mr. Perry says that in other cases it has failed to respond promptly. He points out that from its nature it must depend upon some other means for ascertaining where its services are needed. Therefore, in order to afford the prompt supply that a reservoir gives, there must be the requisite pressure of steam, and the pumps must be always in readiness to act. The only way to secure reliable action of pumps at any moment is to have such a supply of these machines that they are never all needed at once, so that one or more of them may be stopped for needed repairs or adjustment, while the others are at work, without affecting constancy of supply. New systems constantly planned by incompetent engineers for young municipalities are reprehended, and such municipalities are urged to consult competent hydraulic engineers before constructing a water-works system.

"To secure an efficient and effective pressure for fire service the reservoir should be as near the city or town as possible to prevent the loss of head. With head sufficient to give 100 pounds pressure, or two hundred and thirty feet above the general level of the streets, there should be two mains for general delivery, made of cast iron and tested to three hundred pounds before being placed in the trench; said mains to connect to the general distribution supply in such manner that, should one pipe be in any way disabled, the other can be used instantly. The mains must be of such ample size that not more than 10 feet of head will be lost by friction, if all the hydrants in the system were opened at one time."

Mr. Perry gives a useful tabulated statement of the quantities of water that will be discharged per hour from nozzles of different diameters for stated pressure at the play pipe, the horizontal projection of the streams delivered, the vertical heights to which the streams can be thrown, etc. For these data the paper itself must be consulted. In conclusion, he specifies essentials for a good water-supply for fire purposes.

"Four-inch cast-iron pipe should never be used for a hydrant main. It will in a few years become so full of rust that it will not supply a 75-gallon stream, which is no use in case of fire. Concentration of water at a given point is of the utmost importance for fire service. The average consumption of water for household use varies from 40 gallons per day and upwards. For fire service it should be doubled in proportion. Where there is no drainage less water is used, and without drains and sewers waterworks should not be built.

"Stop-valves and gates should be provided, where convenient, on different sections of the mains for shutting off water in case of repair to broken mains. Accidents are liable to happen in opening streets; hydrants should be placed in locations easy of access and easy to be found in case of necessity. Brick cases should be built around every valve. Mains should not be laid less than six feet below the surface of the ground, and the earth should be well rammed down, removing all stones until the last or top layer. Where gravelly soil is found, pipe should go down seven feet deep, especially if traffic is carried on to any extent over it. All valves should be of the open pattern with brass spindles and square nuts for wrenches.

"Two-way frost case hydrants should be used on all cross streets, and in business

or mercantile sections four-branch hydrants of a town or city should be used, and on the two-way hydrants not less than five-inch openings should be had, with faucet for connecting six-inch pipe. On the four-way hydrants there should be a seven-inch opening and an eight-inch pipe. This is one of the most important points for the fire distribution plant. There should be large waterways, and ample means of draining the hydrants when closed, to avoid freezing. A box should be built at the base with open bottom to enable the water to drain off, and, when possible, to run into a drain. The location of hydrants, as far as practicable, should be at the corner of streets, and they should be as close together and frequent as possible,—not over 400 feet apart. Hydrants are cheaper than hose, and they require less attention. Long lines of hose are detrimental to good fire service and to the proper working of the hydrant. Considerable bad work is done by contractors, who take hold of water works contracts, knowing nothing about the first principles of the work, and putting anything that is cheap in price. There should be a rule among corporations building a water-works system that no material should be put into the ground, or covered up, until inspected by a thoroughly competent hydraulic engineer and pronounced satisfactory. The chief engineer of the fire department should, while the work is progressing, make himself fully acquainted with the details of the work, and a plan should be furnished him to make him fully efficient. The only way to have matters right in fire systems is to pay particular attention to them. Where reservoirs cannot be had and pumping machinery is used, pumping machinery should be in duplicate, and located where supply is inexhaustible."

An Interesting Discussion on Naphthaline.

At the twenty-sixth annual meeting of the New England Association of Gas Engineers, reported in *American Gas Light Journal* (March 23), a discussion of the cause of the formation of naphthaline, and modes of preventing its formation, showed that the subject is one needing more systematic investigation than has yet been bestowed upon it. The discussion resulted in the appointment of a committee of investigation, whose report will be anticipated with interest. A member, in opening the discussion, said :

"I think, if we can reduce the temperature of the gas low enough as we send it into our mains, we shall have very little trouble from its formation. About two years ago I rigged up a condenser, and used that with well-water, and brought down the temperature of the gas the year round, or during the warm months of July and August, to 60°. My record during that time shows we had very little trouble with naphthaline. We removed it in this water-condenser. We took out a very large quantity once a month during the warm weather. Lately we have discarded that form of condensation, and have since had more or less trouble with naphthaline ; and during last season, commencing in August, we were closed up. Our mains, services, meters, and inside fittings were choked with it. We had as high as one hundred and fifty complaints a day. As a remedy, I propose to start in again with this water-condenser, hoping to leave the naphthaline in my yard instead of sending it out into the inlets and outlets of the holders, and into the mains and services. I believe it can be done, and I believe that is the remedy for this very great annoyance in our business."

In concluding his remarks, he strongly portrayed the present lack of knowledge upon the subject by saying : " I know of no other question about which we are all so much at sea as we are in respect to the formation of naphthaline. That table would not hold all the papers read and published on the subject; and in one respect we know as little about it to-day as we did twenty-five years ago. We know that it is in some way connected with condensation and temperature, but beyond that we know very little about it."

Another member said that some years ago, when one cold morning he happened to let a little of the benzine vapors and the oily vapors come right out against the

cold water and in the chilly air, the formation of naphthaline was immense and instantaneous. Since then he has "always believed in the theory of that French chemist (M. Bremond) who said that naphthaline was formed by the sudden shock of hot gas against cold water. That is the way it formed at the end of the outlet from the tar-still that morning."

The president of the association declared his inability to throw any light upon the subject. Touching the extent of the trouble, and the desirability that both the causes of, and remedies for, it should be studied, he said: "I suppose we are all more or less interested in this question of what happens in the fall months which causes this trouble in the services—the trouble being universal throughout the States. Two years ago the trouble seemed to be very general indeed. Almost all the companies experienced it, and some of them had very serious trouble. It did not seem to matter whether a company was sending out plain coal gas, or plain water gas, or mixed gas,—the same trouble occurred with all. I am interested in this subject, because we want relief from this trouble in the coming year and the years to follow. I am also interested in it as I am in any problem which I am unable to solve, and I shall continue to be interested in it so long as we have the thing before us,—the formation of naphthaline in this very uncertain way. First, we may have it in our works; next we may have it in the holder, at the inlet, and outlet, and then we may have it in the supplies. We investigate it, and we think we have a clew to its formation, when suddenly we find that our gathered tables of information amount to nothing, because the opposite has been proved in some other location. This illusive character of the problem is what has annoyed me; and, to enable me to study the question more intelligently, after the general trouble which occurred this fall, I had some curves drawn on charts which show its extent in our city for several years past."

Most who took part in the discussion thought the formation begins with the first cool nights in the fall of the year, but one stated that, having examined the inlet and outlet pipes of the holder in the summer (August), he was greatly disturbed by discovering that the twenty-inch outlet was so badly stopped up that there was left scarcely a four-inch opening for the gas to pass through.

Another speaker spoke of the universality of the trouble. Every gas engineer had it to encounter. He said naphthaline forms in all parts of gas works at times, as well as in mains and service pipes. He suggested the employment by the association of a scientific man to make a special study of this formation. This excellent suggestion was not acted upon, the above-mentioned committee selected from members being appointed instead by the president.

Brick Paving for Country Roads.

CAPT. W. S. WILLIAMS, at the seventeenth annual convention of The Ohio Tile, Brick, and Drainage Association, read a paper strongly advocating brick paving for public highways (*Clay Record*, Feb. 26). After giving his experience with a stone road extending from Fremont, Ohio, to Fort Crogan on the Sandusky river, he described the brick roads of the Netherlands, and finds the stone road far inferior to those famous highways. The stone road named has better gradients for its length, perhaps, than any in this or any other country. The road-bed proper was thrown up about three feet in height. A very thick coating of broken stone was then placed upon the road, excepting that part between Fremont and Bellevue, which was constructed mostly of gravel. Numerous toll gates were established as a means of revenue for repairs of the road. Having charge of this road for a number of years as State engineer, Mr. Williams asserts that it did not wear well; that it would cut into numerous ruts, when wet; and that, in dry weather, the wheels would pulverize the stone, which would be blown away in the form of dust. The rough broken stone was objectionable, until worn smooth; moreover, the road was a very expensive one to keep in order, the

revenues scarcely sufficing for the purpose.

"The brick paving of the highways of the Netherlands was done so long ago that there are very few of the present generation who know when it was done. The material used was brick, but not as good as our best quality of shale. The repairs are very small; one man will keep several miles of this pavement in good order. It is apparent from experiments with different kinds of paved roadways that brick is the smoothest, most lasting, the cheapest, and the best.

"In any part of the country the alluvial formation of mixed gravel, sand, and sandy loam is sufficient for a foundation. Sometimes it may be necessary to add more sand or gravel, if convenient. Cinders, or anything which water can pass through readily, will do just as well as broken stone,—anything that will drain and not hold water, such as clay or its equivalents.

"It has never been found essential to put broken stone under a cobble-stone pavement, and a brick has certainly more square inches of bearing surface on the foundation than the average cobble-stone. Neither is it necessary to fill the interstices between the brick with coal tar, as it is plainly evident that brick will shed water more rapidly than cobble-stone, and coal tar is never used in a cobble pavement. The brick, with a plain sand filler, or its equivalent, will soon form a cement around and under the brick that will be impervious to water, and will become tough and hard.

"The road-bed should be thrown up with sufficient crown to shed water nicely, and then rolled with a heavy roller,—the heavier, the better. The ramming and pounding should be done on the foundation, and not on top of the brick.

"A dirt or summer road adjacent to the paved way should always be maintained. The paving brick should contain a large percentage of iron well distributed throughout the mass, and, where this condition exists, the brick will be found to be a homogeneous fused mass of great strength. A light colored brick shows the absence of iron. It is not necessary to have them repressed. As the repressing produces two different structures in the same brick, there will not be the same cohesive strength from center to exterior. The plain, ordinary standard-sized brick is the best."

Disposition of City Waste.

THE report of Col. George E. Waring, commissioner of the department of street cleaning, New York, to the mayor is a document of unusual importance and merit. The disposal of waste in a city of the first magnitude is a far different problem from what it is in a city of moderate proportions. The difference arises more from the enormous bulk to be handled and the distances to which it must be transported than from anything in the nature of the substances themselves, or in their mode of treatment. The subject needs, therefore, to be studied in relation to systemizing delivery, collecting, handling, and transportation, as much as with reference to methods of treatment of the collected substances. This report, accordingly, gives prominence to these features of the subject; at the same time, it discusses methods of disposing of collected waste, particularly garbage reduction and utilization.

An effort has been made to arrive at some better method than depositing wastes, by the scow-load, out at sea, and an investigation of different methods has been conducted, under Col. Waring's direction, by able assistants. Such methods as are in use in various cities have been critically scrutinized, and the literature of the subject has been explored by Mr. Macdonough Craven, Mr. Hawthorne Hill, and Mr. C. Herschel Koyl. Of the result of this systematic effort, Commissioner Waring says:

"While nothing like a definite conclusion has been reached, and while it is, in my judgment, by no means certain that a general contract for final disposition can wisely be entered into in the present state of our knowledge, I do think that more is known now than was known a year ago, and that there is a fair chance of our securing a good result in the letting of a contract for

the incineration or utilization of garbage according to the specifications now advertised."

The report presents in concise form a summary of up-to-date information upon the disposal of city wastes. Its interest and value are enhanced by engravings of apparatus used in treatment of garbage in a number of cities. Dealing, as it does, solely with the disposal of waste, and being well indexed, it is a desirable work of reference for municipal engineers. Its literary style is much above the average of that usually found in municipal and department reports.

We understand that numerous inquiries for this report are coming in from municipal engineers throughout the country. It is to be hoped that Col. Waring will authorize the printing of a sufficient edition to supply the demand, as its high character merits a wide circulation. Both in manner and matter it may be commended as a model document.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply.

†4785. On the Determination of Sulphur in Illuminating Gas and in Coal. Charles F. Mabery (Describes apparatus and a method thought to be more accurate and more easily applied than those in current practice). Am Chem Jour–March. 2800 w.

4787. Laboratory Apparatus for Testing Gas Coals. G. Jouanne (Describes an apparatus that at each charge distils one kilogram of coal, collecting all products, thus enabling a complete analysis of the coal to be made). Am Gas Lgt Jour–March 16. 900 w.

4802. A Lecture upon Acetylene. J. M. Crafts (Delivered before the Soc. of Arts at Boston. Treats of its value as an illuminant; danger in use of liquefied acetylene; temperature of the flame; explosiveness, etc). Science–March 13. 9000 w.

4935. Should Gasholders in New England Be Housed or Not? Fred. H. Shelton (A practical paper opposed to housing holders of 300,000 feet capacity and upward. It is admitted that smaller holders may be sometimes housed with advantage. A discussion follows in which a considerable variety of opinion is expressed). Am Gas Lgt Jour–March 23. 8000 w.

4936. Naphthaline (A topical discussion by members of the New England Assn. of Gas Engineers, at its twenty-sixth annual meeting. A great variety of experience in the formation of naphthaline is given, and theories as to causes and modes of prevention are presented in the discussion, which resulted in the appointment of a committee to investigate the subject and present a report). Am Gas Lgt Jour–March 23. 2800 w.

4938. A Cheap and Reliable Exhaustive Governor. F. Egner (Illustrated description of a governor not patented and of which all parts, except the valve, can be made by any handy mechanic. In the writer's experience it has given better satisfaction than other forms). Am Gas Lgt Jour–March 23. 800 w.

5025. Utilizing Gas Liquor in Small Plants. B. P. Holmes (Paper read at meeting of Ohio Gas Lgt. Assn. Experimental results and conclusions, therefrom, with protracted discussion. First part gives the entire paper and a portion of the discussion. The paper gives description of apparatus and method). Am Gas Lgt Jour–March 30. 6500 w.

5161. Dots and Dashes. E. H. Jenkins (The paper deals in a rather rambling, but suggestive way, with practical points neglected or forgotten. Its suggestive character elicited a spirited and interesting discussion). Am Gas Lgt Jour–April 6 7000 w.

5162. Mains and Service: Their Extension and New Territory. George Light (An excellent paper outlining methods of procedure and mode of ascertaining whether a proposed extension will prove profitable to its constructors, with discussion). Am Gas Lgt Jour–April 6. 3600 w.

5163. Selling Gas. Henry L. Doherty (Holds that undue importance is assigned to the retort house as a source of losses, and points out where losses may come in along the whole line of operations until the consumer is reached.) Am Gas Lgt Jour–April 6. Serial. 1st part. 5000 w.

*5230. Gas-Pipes and Steam-Rollers. Norton H. Humphrys (Deals with the damaging effects of steam road rolling in gas-lighted towns, upon the gas pipes under streets. It appears that this has proved serious in some places). Jour Gas Lgt–March 31. 3000 w.

Sewerage.

4866. Alignment of Tile Sewer Pipe in Macon, Ga. (Illustrated description of devices and methods successfully employed). Eng Rec–March 14. 300 w.

4983. A Concrete Storm-Sewer in Brussels, Belgium (Interesting, instructive, illustrated description of large concrete works designed to carry the storm flow of a stream that flows through an important part of the city, and attains a great volume after each heavy rainfall). Eng News–March 26. 500 w.

*5024. The Disposal of Sewage and Refuse (Abstract of a lecture delivered by C. S. Cannell, before the educational department of the Norwich Co-operative Society. The declaration that the people of England are wasting a grand

We supply copies of these articles. See introductory.

opportunity, is followed by suggestions of methods whereby the sewage now floated out to sea, may be utilized on land as a fertilizing agent). San Rec-March 20. 1200 w.

*5042. The East Molesey Sewage Works (General description of plant and methods with editorial remarks). Mach, Lond-March 15. 2500 w.

5133. Sewage Filter Beds at Waterloo, Ont. (Illustrated detailed description of a plant well adapted to the use of a small town). Eng News-April 2. 900 w.

*5155. Sewer Discharge and Velocity. Albert Wolheim (Formula, diagrams, and two tables, one giving proportional values of velocity and discharge for circular sewers at different depths of flow and when flowing full). Pav & Mun Engng-April. 300 w.

Streets and Pavements

*5153. Why Good Paving is Essential to the Success of a City. J. W. Howard (Facility of traffic which can only be secured by good paving, is assigned as the reason). Pav & Mun Engng-April. 1800 w.

*5154. From Cobblestones to Asphalt and Brick. N. P. Lewis (Specially condensed from official report to the chief engineer of Brooklyn). Pav & Mun Engng-April. 2800 w.

Water Supply.

*4732. Pure Water for Drinking and Cooking. S. P. Axtell (Showing the importance to municipalities of adopting a dual water-supply system). Eng Mag-April. 3200 w.

4760. Mr. Mansergh's Report on the Water Supply of Toronto (A most interesting and instructive document. The writer is an eminent English engineer, employed by the authorities of the city to report on the supply of the city, and paid $15,000 for his services. In view of this large fee, and the high reputation of the author of the report, it will attract unusual attention). Eng News-March 12. 3000 w.

4774.—75 cts. The Water System of Burlington, Vt. F. H. Crandall (Very complete illustrated detailed description, followed by interesting discussion). Jour New Eng Water Works-March. 4500 w.

4775.—75 cts. On the Sanitary Condition Past and Present of the Water Supply of Burlington, Vermont. William T. Sedgwick (A very interesting and instructive paper. It gives results of analyses, and traces diseases that have prevailed in the city to organic impurities in the water taken from Lake Champlain). Jour New Eng Water Works-March. 5800 w.

4776.—75 cts. An Electrical Pumping Plant. Charles A. Hague (The incidental benefits that may attend the use of electricity for pumping are noted, and it is shown that for some situations, electrical power pumping may be cheaper than the direct use of steam. The data given and conclusions drawn will however fail to obtain general acceptance. An interesting discussion that exposes some vulnerable points accompanies the paper). Jour New Eng Water Works-March. 7000 w.

4868. Mr. Mansergh's Report on the Toronto Water-Works (Editorial review and summary of this able document). Eng Rec-March 14. 2300 w.

4877. Pipe Distribution and Water Supply for Fire Service. William Perry (The different systems in use are named and preference given to the gravity system. The carrying out of such a system in all its details forms the subject of the body of the article). Can Eng-March. 1400 w.

4889. Erie, Pa., Water Works (Illustrated detailed description). Fire & Water-March 21. Serial. 1st part. 800 w.

4890. New Pumping Station, Allegheny City, Pa. (Illustrated description). Fire & Water March 21. 600 w.

4895. The Syracuse Water-Works (Illustrated detailed description). Eng Rec-March 21. 4000 w.

*5014. London Water Supply (Editorial review of a bill introduced into the House of Lords, providing for vesting the water supply of London in a public trust). Engng-March 20. 2000 w.

5037. The Specifications for the New Bedford Force Main (These specifications are for a main eight miles long and forty-eight inches diameter, of riveted steel). Eng Rec-March 28. 1400 w.

5038. Mr. Allen Hazen's Report upon the Jersey City Water Supply (The conditions of obtaining a good water supply for Jersey City make the problem one of such difficulty that this report, dealing with these conditions, is of more than ordinary interest. The practicability of a filtered water supply is specially discussed and is viewed favorably, and the cost of such a plant is placed at $1,235,000). Eng Rec-March 28. 1800 w.

5134. The Feasibility and Cost of Purifying Badly Polluted Water (Editorial review of the report made by Mr. Allen Hazen, for Noyes and Hazen, of Boston, on the feasibility of a system of filtration of water for Jersey City water supply, and an estimate of its cost). Eng News-April 2. 2400 w.

5147. Record Making Pumping Engine, Chestnut Hill Pumping Station, Boston, Mass. (Illustrated detailed description, dealing exhaustively with an exceedingly instructive and interesting design, and tabulated data obtained from an exceedingly thorough test. The extraordinary result of one steam horse power per hour, on a consumption of 1.146 lbs. of coal is recorded). Power-April. 3300 w.

5247. The New Pump at the Lewiston Water-Works. Charles L. Newcomb (Illustrated detailed description of pump driven by water power. The whole question of design in a pump of this kind, with its special requirements, was dealt with). Eng Rec-April 4. 1400 w.

Miscellany.

4808. The Legal Status of Electrical and Gas Enterprises in Massachusetts Defined. E. W. Burdett (Abstract of an address before the Electric Potential Club at Boston). Elec-March 11. 2200 w.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

The First Railway in China.

So little is known of the internal affairs of China that a few notes from Mr. Sheridan P. Read, United States consul at Tien-Tsin, from the *Engineering News* (Feb. 27), may be of interest.

"Seventeen years ago the only semblance of a railway in the whole Chinese Empire was an iron tramway, about 10 miles long, at the Kaiping coal mines, 80 miles from Tien-Tsin. Small cars loaded with coal were pushed over this tramway by coolies, who received 10 cents in Mexican silver for 12 to 14 hours' work per day. About this time the works were placed under the charge of Mr. Claude W. Kinder, M. Inst. C. E. and M. Am. Soc. C. E., an energetic young English engineer, who at once ventured to propose many changes tending to increase the efficiency of the plant and to decrease expenses. The Chinese directors of the mines did not regard his efforts with favor, and the Peking government promptly vetoed his attempts at progressive measures. But, despite the Peking authorities and native superstitions, Mr. Kinder determined to have a locomotive, if he had to build it himself, and he did build it. Four small driving wheels were ordered from the United States; a disabled stationary engine furnished the boiler, and a broken-down winding engine the cylinders. With few tools and little outside help these parts were fitted together, and the 'Rocket' was at last put upon the track with great yellow dragons emblazoned upon its sides. It was the first locomotive in China, and was a startling object to the Chinese, who expected all manner of dire consequences as the result of the innovation. The Peking authorities were horrified and at once ordered the Rocket dragon to be summarily suppressed. But the Chinese mine directors permitted it to be used in short trips inside the yard, at first, and its travels were gradually extended without producing the war, pestilence, and famine expected. At last imperial permission was granted for its free use.

"This was the beginning of railways in China, and the builder of the first locomotive is now chief engineer and superintendent of the Imperial Railways of China. The line, as at present finished, begins at Tien-Tsin; it then passes 27 miles to Tongku, 6 miles from the mouth of the Pei-ho, at the Gulf of Pechihli. From Tongku the line swings northeast to Shang-Hai-Kuan, the terminus of the present operated road, and 177 miles from Tien-Tsin. Surveys have been made for an extension of 200 miles beyond Shang-Hai-Kuan, and about 10 miles have been built. When finished, the railway is to reach Kirin, the center of Manchuria, and a branch is to be built to the head of the Gulf of Liaotung, where there is a good harbor. Active work on this line was interrupted by the late Chinese-Japanese war.

"The greater part of this railway runs through a flat, alluvial country, subjected to heavy floods during the rainy season. The sharpest curve has a radius of 1,000 ft., and there is only one of these, made necessary to avoid two cemeteries. The most of the curves have not less than 3,000 ft. radius, and the maximum gradient is 0.75 %. The country traversed is strictly agricultural, with no large towns, and the people are very poor. The Kaiping coal mines are the only mining industry in operation, though deposits of coal, iron, gold, and silver only await intelligent development. All trains are 'mixed' freight and passenger, with four trains each way daily from Tien-Tsin to Tongku, and one train daily from the latter point to the terminus. The average speed is 15 miles per hour, and, while the road has paid its running expenses, it yields no interest on its first cost of construction and equipment.

"The building was done after English methods and ideas of permanency, without regard to first cost or work required of it. No wooden structures find place upon it, stone, brick, concrete, and steel being the materials used.

"The wages paid are as follows, all payments being at the rate of Mexican silver: common laborers, $4 per month; firemen, $5 to $6; enginemen, $14 to $45. The two highest-paid native enginemen now on the road receive $41 and $46 per month, while an English engineman receives $200 per month, as a maximum. The section-hand receives $4 per month; foreman, $6; a native clerk, $80, if he can speak and write both Chinese and English. The cost of timber is very great, and wooden trestles are out of the question. All station houses are built of brick, plastered inside, for the same reason, and station platforms are made of stone or concrete filled in with earth and cinders."

Hydraulic System for Working and Locking of Railway Points and Signals.

THE importance of a reliable switch and signal service is recognized by all railway men, and the following description will, no doubt, prove interesting, particularly since the system described has been in successful operation for years. *Engineering* (London, Mar. 6) thus describes it:

"Instead of the points and signals being moved by means of rigid rods and wires, as hitherto done, involving considerable effort on the part of the signalmen in pulling over the levers, particularly when the points and signals are at very great distances from the cabin, they are worked by means of fluid under pressure, preferably a mixture of water and glycerine, conveyed by means of small pipes laid underground to double pistons fixed near the points, or to small single pistons attached to the signal-posts, the necessary power being generated by a pump worked by hand, steam, or gas, as circumstances render necessary or convenient. The power so generated is stored up in an accumulator ready for use. By this system the working of points, however distant they may be from the station or cabin, is accomplished without any physical effort on the part of the signalman; the little levers used for turning on the pressure can be moved by a child; the number of signal cabins and signalmen can be reduced; station yards are kept clear of the usual multiplicity of rods, rollers, cranks, compensating levers, and other mechanism; smaller cabins are required; in fact, the little levers can be, and are frequently, fixed in the station-master's office or some room in the station buildings, and so considerable economy is effected.

"It is obvious that it is of most vital importance that, whilst points are moved to and fro with the greatest facility, means should be provided for securing them firmly in position before a train is allowed to pass over them, and for assuring the operator that such closing and locking of the points has been perfectly accomplished. This very important object is attained, by the system under review, in the most perfect manner. Each set of points is moved to and fro by means of two pistons, which are put in alternate communication with fluid under pressure and a discharge reservoir. When the fluid has moved the points by means of the pistons, it is allowed, by the opening of a valve worked by the point lock attached to the points, to pass back to the signal cabin, and, by means of a small plunger fixed to the lever-locking frame, to take a lock off the point lever, so permitting the operator to pull it completely over, releasing the signal lever, which can then be moved, and the signal worked to permit a train to advance over the points.

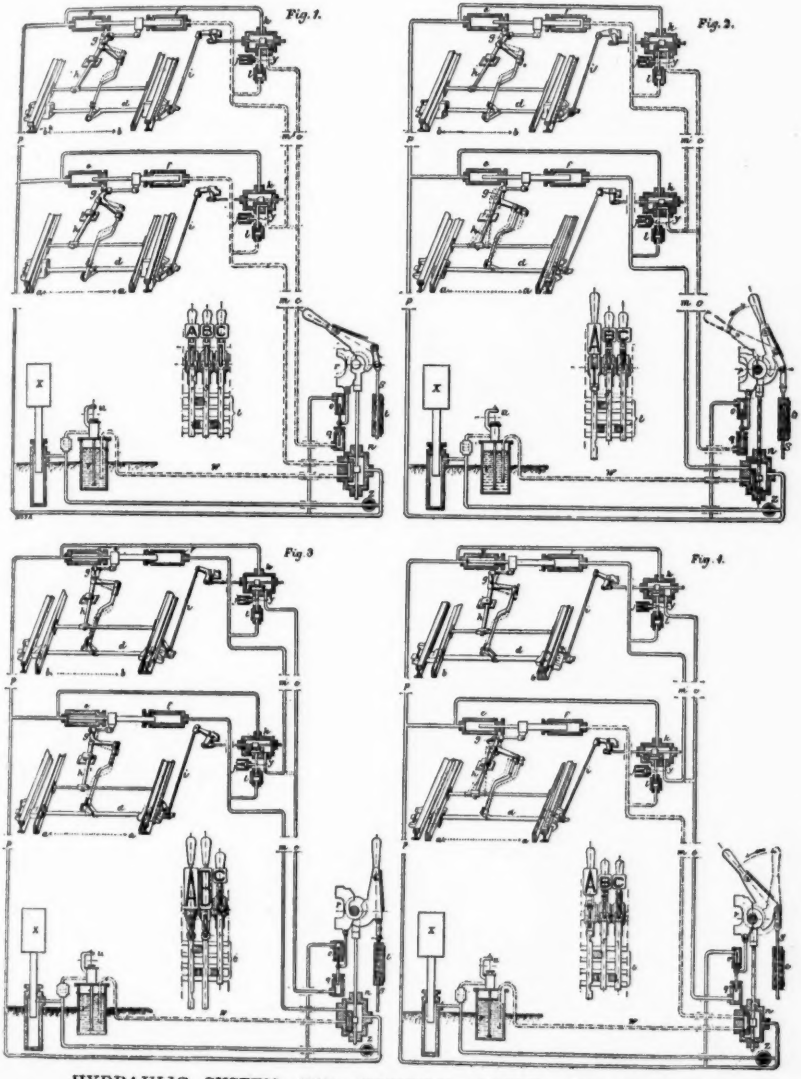
"The first and partial movement of the point lever turns on the fluid under pressure to the points, unlocks them, moves, and then locks them in their altered position, and, after this is accomplished, the fluid returns to the cabin and releases the point lever, which can then be pulled the remainder of its stroke for the purpose of releasing the appropriate signal lever. Thus an infallible detector is provided to every pair of points, and their movement is perfectly controlled, irrespective of distance.

"The mixture of a certain quantity of glycerine with the water obviates all diffi-

culty from frost, and prevents all risk of the fluid freezing during the most severe winters. The apparatus in actual work has been subjected to very severe tests, with a temperature as low as 20 deg. below zero Fahr., and no inconvenience has been experienced from congelation."

The method of working, illustrated by the accompanying diagram, is thus described:

"The lever, A, is worked by hand in two movements. The first part of the movement (⅔ of the stroke) is unimpeded, and works the valve, *n*, causing the move-



HYDRAULIC SYSTEM FOR WORKING POINTS AND SIGNALS.

ment of the differential plunger, *e f*, which works the bolt, *d*, and the points, *a* and *b*. The second part of the movement (⅓ of the stroke) is dependent upon the position of the control lock, *r*, which separates the two movements.

"The lever, A, takes four positions, shown in the four diagrams,—that is, two controlled positions (Figs. 1 and 3), and two working positions (Figs. 2 and 4). The points, *a* and *b*, and the facing point lock, *d*, are hydraulically worked by the differential plunger, *e f*, the working of which causes three successive movements:

"1. The unbolting of the points by the first rotation of the facing point lock, *d*, by means of the crank, *g*.

"2. The movement of the points by the lever, *h*.

"3. The bolting of the said points by the second rotation of the facing point lock, *d*.

"It will be noticed that each locking block is mounted centrally on the rod, *d*, and that each is broad on one side and narrow on the other. The broad portion interposes between the rail and the point when the point is open, whilst the narrow portion comes up outside the point, jamming it against the rail when that point is closed. On unlocking the point as described, the rotation of *d* continues until the broad portion of the locking block bears on the underside of the closed point. Under these conditions it cannot move further, until the point has been moved over.

"The facing point lock, *d*, takes three distinct positions, two for locking the points (Figs. 1 and 3), and one allowing points to be worked (Figs. 2 and 4). The working of the lock, *r*, upon the point lever is done hydraulically and automatically by the facing point lock in its last movement. The facing point lock, *d*, by the link, *i*, acts on the control valve, *k*, and on the differential plunger, *o q*; this works the lock, *r*, which acts as a control or release lock on the point lever, A. In operating the plant, the signalman, if he desires to shift the points, first moves the point lever, A, over as far as the lock, *r*, will let him. During this motion the lever, A, mechanically locks the signal lever, with which the signals, corresponding to the original position of the points, are operated. At the same time the signals corresponding to the new position of the points still remain locked. As soon, however, as the points are locked in their new position, the control lock, *r*, on lever A, is raised by means of water admitted to the hydraulic plungers, *o*, *q*, through the valve, *k*, which is operated when the bar, *d*, locks the points. Knowing the points are thus secure in place, the signalman moves A over to the full limit of its travel, and in doing so unlocks the signals corresponding to the new position of the points. The interlocking of the signal and point levers is purely mechanical. The locking of lever C, which should not be moved at the same time as lever A, is accomplished by means of a horizontal tappet in the first sixth part of the stroke of lever A. This precedes the movement of the valve, *k*, controling the points, *a* and *b*. The releasing of the lever, B (which ought not to be released until lever A is pulled completely over), is accomplished by a horizontal tappet in the last sixth of the stroke of the lever, A.

"The accumulator, X, holding 1, 2, or 4 gallons, and arranged for 50 atmospheres' pressure, is sufficient for 50, 100, or 200 movements. The pipes are charged by a pump ordinarily worked by hand. A small gas engine of ¼ horse-power suffices for larger installations. The liquid (water and glycerine) employed is used over and over again, being brought back to the reservoir by a return pipe. When the accumulator is charged, the state of the hydraulic installation is readily seen. Should any leakage take place, it is shown by the falling of the accumulator.

"From the foregoing description it will be seen that this system of hydraulic working and locking of points and signals is extremely simple. In very many instances where difficulty is experienced in finding room for cabins of the ordinary kind and size, this system doubtless proves extremely valuable. The Tower Bridge was interlocked on this system by Messrs. Saxby and Farmer, Limited, of Kilburn, London,

who are the manufacturers of the apparatus under the Bianchi-Servettaz patents."

Raising the Center of Gravity of Locomotives.

GOOD practice is a relative term depending largely upon local conditions, and so it happens that the type of locomotive we find the better does not at all correspond with the English or French ideal. Yet there are certain tendencies which are general, and foremost among these is the tendency to elevate the boiler and raise the center of gravity of the engine. Some time ago the *Genie Civil* published an article upon this subject, which was translated in the February number of the bulletin of the National Railway Congress and subsequently appeared in the *Railway Review* (Mar. 28); in it this subject is fully and intelligently treated. Of course the point of view is a French one, and interesting in consequence. Speaking of the height of boilers in express engines, the author places the height of the center of English boilers at from 7 ft. 5 in. to 7 ft 10¾ in. above the rail; in Belgium they have reached 7 ft. 9¼ in.; in Austria, 8 ft. 0¼ in.; while the maximum height in the United States is 8 ft. 11½ in.

To quote from the article: "The height nowadays regarded as the minimum in the United States is actually greater than the maximum in Europe. Fig. 1 shows in diagram on the same scale a standard French type of express engine compared with one on an American road, which gives a better idea than mere dimensions of how far the Americans have gone beyond us in the power and height of their engines. Also Fig. 2 shows front views of three classical types of engines,—an old Crampton, an express engine from the Midland of England, and one of the New York Central engines."

The advantages gained by height are given in these words: "When the flanges of the wheels of the locomotive strike the rail on a curve, everything else being equal, a jar is given which is all the more violent in proportion as the center of gravity is lower. If we suppose the center of gravity to be at a level with the rail, the strain due to the centrifugal force will be entirely transmitted to the rail; if the center of gravity were removed to an infinite distance above the permanent way, the engine would no longer have any stability, and, under the influence of an infinitely slight centrifugal force, would balance itself on the outer rail without causing any appreciable strain tending towards displacement. In practice, every engine occupies an intermediate position between these extremes, and we can draw the conclusion that, the higher an engine is, the less will it tend to displace the permanent way. To make it absolutely safe, we shall only have to give it the minimum stability consistent with its running no risk of being upset when

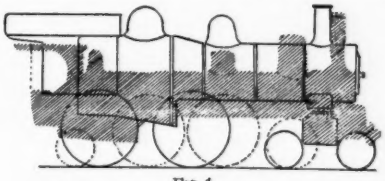


FIG. 1.

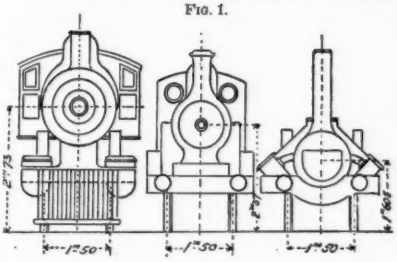


FIG. 2.

passing at full speed over curves of the smallest radius which it will have to pass; and experience shows that this limit is not exceeded by the most lofty American engines."

In enlarging upon the relation between raising the height of boiler and the center of gravity he makes the statement that, in a case cited, the center of gravity was raised but twenty-five per cent. of the increased height of boiler. The general conclusions arrived at are thus combined:

"1. Within certain limits, which have so far not been reached in Europe or even in America, raising the center of gravity of engines has nothing but good results. It results in decrease in strain on the per-

manent way and on the parts which go to make up the engine, wheels, axles, boxes, and frame plates. The running of the engine is made smoother because the springs come more into play under the action of lateral motion and in running around curves; the tendency to derailment is decreased by the increase of the load on the outer rail when curves are run over at a high rate of speed.

"2. Raising the boiler seems to be the most practical, the most simple, and the least costly method of increasing engine power, as it allows of the barrel having a diameter greater than the space between the tires.

"3. As the boiler does not, on the average, make-up more than one-quarter of the weight of an engine, if it be raised a given amount, the center of gravity of the whole is only raised about a quarter of this amount.

"4. The center of gravity of the highest engines used at present is much lower than that of passenger carriages and loaded wagons; it can, therefore, be considerably raised without fear of endangering safety."

The New Tramway.

IN order to overcome the evils of the trolley system, the annoyances of steam traction, and the cost of cable roads, the "Compagnie des Omnibus" of Paris have devised a compressed-air system, which possesses many advantages. Vol. 1, No. 1, of *Compressed Air* (March), a bright little house organ devoted to the "useful application of compressed air," contains a translation from the *Figaro*, in which the road referred to is briefly described as follows: "Though of light weight and graceful form, it is sufficiently strong to draw several cars and accommodate forty passengers." It can back, stop quickly, and start with equal facility, and is free from disagreeable noises and odors.

"At starting, the tramway is charged with a sufficient quantity of compressed air to enable it to run for four kilometers, beyond which distance it becomes self-charging and by the following ingenious device.

"Before each waiting station the rails are provided with a pipe, which is set in the hollow over which the wheels pass. The wheels cause a smaller pipe to spring from the ground and enter a hydraulic joint placed under the tramway, by which means the receivers installed there are connected with the underground conduit. The amount of compressed air received in a few seconds is sufficient to propel the motor car for a further distance of four kilometers. This done, the small pipe returns beneath the surface, and is automatically covered with an iron plate, over which men and horses alike may pass with perfect safety."

This system has been adopted at Saint-Quentin, Angouleme, and Lyons.

SPEAKING of the influence which the advances now in progress in Japan are likely to exert upon surrounding oriental nations, of the signs of an awakening in China now plainly perceptible, and of its probable effect upon American trade, *Locomotive Engineering* (April) says:

"Adversity often stirs up nations and individuals to efforts formerly thought beyond capacity. The hammering which China received from Japan seems to have stirred the Celestial Empire into sentiments of progress that a thousand years of peace would have failed to excite. The first manifestation of this is the report that the Chinese Government has signed a contract with an Anglo-American syndicate to build a railway from Hankow to Pekin, a distance of 700 miles. This line has been contemplated for some years, and was sanctioned by the emperor in 1889. Chinese public sentiment, however, is strongly adverse to the introduction of modern methods, and every obstacle has been placed in the way of this enterprise. The completion of and operation of a real railway in China—for the pioneer road now running from Tientsing is chiefly a coal carrier and has little but local business—will doubtless work a revolution in sentiment and ultimately result in a very large amount of railway building in the great empire, in which American builders and operators will have no small share."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

*4729. Railroad Corporations in Practical Politics. Cyrus C. Warman (Showing that the efforts of railroads to control politics in their interest are in the long run unprofitable). Eng Mag-March. 3500 w.

*4733. The Future of Elevated Railroads. Eugene Klapp (Showing how the construction and operation of elevated roads may be sufficiently cheapened to make them practicable in cities of the second and third ranks). Eng Mag-April. 2800 w.

4756. A Combination Steam and Electric Locomotive (This engine is unique in design. It consists of a box-car-like structure on wheels containing an engine run at high economy, which drives dynamos furnishing current to the motors attached to the driving wheel axles. It is intended for main line work and does away with the trolley system). Eng News-March 12. 500 w.

4757. Colors for Night Signals (Abstract of report of committee of the Railway Signaling Club. They recommend that the present system of red for danger, green for caution, and white for clear, be retained, but that the danger of colored glasses breaking be reduced, and that the colors should be so decided as to be unmistakable). Eng News-March 12. 1800 w.

4758. The Size and Capacity of Freight Cars for Interchange Service (Editorial discussion of the report of the special committee on "Large Cars," to the N. Y. Railroad Club. Some interesting figures are given on weights and dimensions of cars on various roads). Eng News-March 12. 1800 w.

4759. The Supreme Court Commission's Report on the New York Rapid Transit Ry. (The most important work now under way in the United States. The editor summarizes the history and present status of the scheme and makes extracts from the report. The underground system estimated to cost less than $50,000,000, is fully discussed). Eng News-March 12. 3800 w.

4761. The Hoskins Gasoline Motor for Street Cars (This motor car is built in the United States and is being tested at Dayton, Ohio. All machinery is beneath the body of the car, the engines are in motion constantly and engage with the drivers by means of friction pulleys). Eng News-March 12. 700 w.

4766. Wear of Tires on the Passenger Engines of the New York Central & Hudson River Railroad for the Past Twenty Years (A valuable paper by Mr. P. H. Dudley, with tables and diagrams, showing the influence of the modern rail with a broad head, on the wear of locomotive tires. It is shown that the engines running on the old 65-lb. rails made 19,400 miles for each sixteenth of an inch worn off the driving tire; while engines running over the more recent broad headed rails, and in part over rails weighing over 100 lbs. to the yard, showed an average of 29,046 miles for each sixteenth of an inch tire wear). R R Gaz-March 13. 2500 w.

4767. Some Railroad Matters in England (A summary by Mr. W. M. Acworth, of recent railroad matters in England, covering legislation with regard to light railroads, some long and fast runs and improvements in passenger rolling stock, together with other matters). R R Gaz-March 13. 2500 w.

4770. Drop Smoke Stacks for Roundhouses (A description of the drop smokestack as used on the Chicago, Burlington and Quincy Railroad, with detailed drawings). R R Gaz-March 13. 600 w.

*4782. Modern Engines of the Brighton Railway. Ill. W. B. Paley (The article gives a good idea of the types of engines which an English road finds it necessary to adopt to meet its varied traffic demands). Ry Wld-March. 2500 w.

*4783. A Rural Steam Tramway in Sussex (A private enterprise in the line of light railways. The gauge is 3 ft., and the road is fitted with 26 lb. rails, and is 1¾ miles long. The traffic is entirely local). Ry Wld-March. 1300 w.

*4784. American Experiments with Electric Conduit Tramways (The editor discourages such installations, giving his reasons). Ry Wld-March. 1400 w.

*4791. Hydraulic System for Working and Locking of Railway Points and Signals (A very simple and compact method is here given and illustrated by cuts of the levers, valves and gears). Engng-March 6. 3300 w.

†4794. Report of the Committee on Large Cars (The article is especially valuable as containing the letters printed in full which the Committee received from various authorities on railroad matters and which contain interesting data). Pro N Y R R Club-Feb. 20. 22000 w.

†4795. Report of the Committee of Mechanical Superintendents, Appointed by the Central Traffic Association and the Western Freight Association (A report on the dimensions of freight cars. The tabular statements of various loads are interesting). Pro N Y R R Club-Feb. 20. 1800 w.

†4796. Report of the Western Classification Committee (A lengthy discussion among the various members on the limiting of size and weight of freight cars). Pro N Y R R Club-Feb 20. 13000 w.

4815. A Suggestion for Testing Street Railway Motors. George T. Hanchett (Illustrated description of an apparatus which is designed to effectively accomplish a thorough electrical testing of the car in a systematic manner, the amount of time consumed being negligible). Elec Ry Gaz-March 14. 800 w.

*4851. Third Rail and Feeder Equipment of

the Lake Street Elevated, Chicago (The method of construction is fully illustrated and described). St Ry Rev–March 15. 600 w.

4869. A New Tramway Rail (The rail adopted for surface railways in N. Y. City. The lip is raised to a level with the head, thus offering no obstruction to traffic). Eng Rec–March 14. 400 w.

4878. Railroad Enterprise in China (A letter to the editor from Shanghai, supplemented by information gleaned from other sources, concerning the present status of railroad building in China). R R Gaz–March 20. 1600 w.

4879. Tonnage Rating of Locomotives (Discussion before the Northwest Railway Club, showing testing and rating methods adopted by various roads, and the advantages of rating locomotives by the weight rather than by number of cars). R R Gaz–March 20. 1900 w.

4880. Experiments with Locomotive Exhaust Pipes and Smokestacks (An account of some very elaborate experiments made in Germany, in the years 1892 to 1894, to ascertain the effects of different shapes and proportions of exhaust pipes and smokestacks for locomotives. A very elaborate investigation). RR Gaz–March 20. 4000 w.

†4898. Automatic Brakes for Goods Trains (Recommending the use of continuous brakes as a safety measure, with reasons supporting the position taken). Ind & East Eng–Feb. 22. 1500 w.

4901. Rapid Transit in New York (Showing how the present laws must be modified in order to induce a contractor to take up the work of building an underground railway in New York city). Bradstreet's–March 21 400 w.

4902. Improved British Railway Returns (The returns from the various roads show a general increase in revenue). Bradstreet's–March 21 500 w.

*4919. Railway Economics (Showing why the operating expenses are higher and the receipts per mile of road are lower than in other countries). Eng, Lond–March 13. 1500 w.

*4924. Triple Cylinder Locomotives (A glance at our American compound locomotives from an English standpoint). Eng, Lond–March 13. 2000 w.

4930. Boston's New Union Station (This station and train-shed will be the largest in the world. It will have twenty-three tracks, and cover an area of 495,000 sq ft. Interesting figures concerning other stations are given). Bos Jour of Com–March 21. 900 w.

4932. Distant Signals and Care of Interlocking Apparatus. Charles Hansel (Letter to the editor taking the position that the power to change signals should be taken from the operator after the train has entered the interlocking limits). Ry Rev–March 21. 1500 w.

4933. Louisville (Ky.) Terminal of the C. C. C. & St. L. and the C. & O. Railways (Description, illustrated by track plan, view and cross section). Ry Rev–March 21. 1500 w.

4952. Some Recent Developments of the Trolley (Illustrated description of mail and express cars and of an electric trolley snow plow). Sci Am Sup–March 28. 1400 w.

4965. The Gorge Road at Niagara Falls (An illustrated description of the Gorge Railroad, which is designed to prove a great attraction to all lovers of natural beauty). Sci Am–March 28. 1200 w.

4981. An Electric Inclined Railway at Great Falls, Mont. (A counter-balanced incline railway 400-ft long, and on an incline of 22° 10′ with the horizontal). Eng News–March 26. 400 w.

4988. Gate for the Wallabout Drawbridge, Brooklyn, N.Y. (An ingenious device by which a wide gate can be quickly closed and not occupy much space. The article is illustrated by views and detail drawings). Eng News–March 26. 900 w.

4990. Proposed Southern Union Station in Boston (A general description of a plan for a new union railroad station in Boston, on a very extensive scale, showing location in general, and arrangement of tracks and head-house). R R Gaz–March 27. 1500 w.

4991. Signal Standards on the Pennsylvania Lines West of Pittsburgh (A description with diagrams, of the arrangements adopted as standard for the disposition of signals, together with a statement of the principles governing the arrangement. An important illustration of the subject). R R Gaz–March 27. 1000 w.

4992. The Hauling Capacity of Locomotives. H. H. Vaughan (Extracts from a paper presented before the Northwest Ry. Club, explaining the methods of rating locomotive loads adopted on that road. For some time it has been the practice to load locomotives by actual tons rather than by the number of cars). R R Gaz–March 27. 2500 w.

4997. A Surface-Contact Street Railway System (Illustrated description of an interesting system now in course of experimental test on 34th st, N. Y. The latest Johnson Lundell system). Elec Wld–March 28. 900 w.

*5020. A Forgotten Chapter in Railway History. G. A. Sekon (The discussion of combined locomotive and railway carriage construction, giving cuts of two designs planned by W. B. Adams, about 1848). Mech Wld, Lond–March 20. 2300 w.

†5026. The Zone System (An interesting report showing the tendency in the distribution of passenger traffic in Hungary, with editorial comments). Ind & East Eng–Feb. 29. 1800 w.

5047. Advantages of Raising the Center of Gravity of Locomotives (From the Bulletin of the National Railway Congress, showing the increased safety gained in high engines). Ry Rev–March 28 1200 w.

5048 The Hauling Capacity of Locomotives (Extracts from discussion on a paper by H. H. Vaughan of this title read before the Northwest Railway Club). Ry Rev–March 28. 3200 w.

5049. Piece Work in Car Shops. G. L. Potter (Abstract of a paper read before the Western Railway Club advocating piece work). Ry Rev–March 28. 2000 w.

*5059. The Rouen Electric Tramways (Illustrated description of the largest network so far

equipped for electric traction in France). Elec Eng, Lond–March 20. 2600 w.

†5081. The System of the Orleans Railroad Company, New Orleans, La. Ill. (A thorough description of plant and operation. One of the novel features is a road bed construction on swampy ground, the bottom of the excavation being floored with cypress planting). St Ry Jour–April. 3800 w.

†5083. The Design of Testing Stations for Street Railways. R. W. Conant (The importance and character of such a station is intelligently treated and the installation of the West End St. Ry. of Boston is described. The subject of insulation is given special attention). St Ry Jour–April. 4500 w.

†5084. English Methods of Cable Track Construction. Alex. McCallum (English and American methods are compared showing greater economy as lying on the side of the English type). St Ry Jour–April. 1800 w.

†5085. Car House Construction in Boston (Each part is described and illustrated by place and section. The design embodies the results of long experience). St Ry Jour–April. 1100 w.

*5105. Philadelphia and Reading Shops. A. S. (The history of this well known shop is related, and the present equipment is described). Loc Engng–April. 2800 w.

*5106. Old B & O. Engines (Illustrations of five curiosities in locomotive practice). Loc Engng–April. 200 w.

5110. The Electrical Equipment of the Orleans Railroad, New Orleans, La. (Illustrated description). Elec Eng–April 1. 3000 w.

5123. Interlocking at Toronto (A short description, with illustrations, of the interlocked switches and signals recently installed in the yards of the Grand Trunk Railway in Toronto. The material used is English and this plant is the largest and most important installation of English signal apparatus in this country). R R Gaz–April 3. 800 w.

5124. Colors for Night Signals (An abstract of a committee report and discussion on this subject, before the Railway Signalling Club, Chicago, also an editorial on the same subject). R R Gaz–April 3. 2400 w.

5126. Lubricating Rails on Curves (A short account of some recent experience in Germany with the use of lubricants on the gage side of rails on very sharp curves. A considerable reduction in wear of material and in power expended in hauling is obtained at trifling expense). R R Gaz–April 3. 600 w.

5127. The Supreme Court Decision in the Brown Case (A short editorial discussion of the recent decision in this celebrated case. This is the case which has been fought for some years between the Interstate Commerce Commission and the railroads, involving the right, under the constitution, of a witness to refrain from giving incriminating testimony. The Supreme Court of the United States now upholds the Interstate Commerce Commission in the contention that officers of the railroads must give testimony and rely upon the provisions of the law of Feb. 11, 1893, for protection). R R Gaz–April 3. 1100 w.

5131. Rules for Operation and Maintenance of Interlocking Signals (Report of H. D. Miles, W. C. Nixon, and Henry M. Sperry, committee for the Railway Signaling Club, Chicago. The rules are concise and condensed). Eng News–April 2. 2400 w.

5152. The New Tramway. Charles Chincholle (Translated from *The Figaro*, showing how compressed air is utilized in street car service in Paris). Compressed Air–March. 700 w.

5181. Track Elevation—N. Y. N. H. & H. R. R. in Boston. (Illustrated detailed description of plans). Ry Rev–April 4. 1200 w.

5183. Ornamentation in Locomotive Painting. A. Ashmun Kelly (The writer discourses upon the aesthetic effect on the enginemen and cleaners). Ry Mas Mech–April. 900 w.

5184. The Piece Work System (The system adopted by the Baltimore and Ohio R. R. is explained and a schedule of prices paid for a large number of separate parts is presented). Ry Mas Mech–April. 600 w.

5185. Further Details of Sand House at Argentine, Kansas (Illustrated description). Ry Mas Mech–April. 150 w.

5186. A Notable Water Tank Installation (Tank at Elmhurst, on the Chicago & Northwestern Railway. The controlling ideas in design were quick delivery of water, durability and cost. Drawings of the valves and pipe connections are given with a view of the tank). Ry Mas Mech–April. 550 w.

5231. Chicago & Northwestern Locomotive Testing Plant (Illustrated detailed description). R R Gaz–April 10. 1300 w.

5232. New Interlocking Machine of the National (Illustrated detailed description). R R Gaz–April 10. 700 w.

5233. McPherson's Safety Switch and Frog (Illustrated detailed description). R R Gaz–April 10. 400 w.

5234. The Question of the Big Car (Discusses the effects of increase of length of box cars, as being increase in earning capacity and decrease of operating expenses. But as this is only one side of the question, the writer concludes with a series of formulated questions designed to elicit discussion of other phases of the subject). R R Gaz–April 10. 1700 w.

5235. Conditions Affecting the Future of Our Railroads. George B. Leighton (Notwithstanding the merited or unmerited adversity brought upon railroads by the recent commercial depression, an examination into the present status of railroads in the United States, leads the author to conclude that very many of the lines at present constructed will prove safe investments as to their bonds, and many of them will regularly pay fair returns on their stock). R R Gaz–April 10. 2200 w.

*5243. Details of the Fast Run on an American Railway (The run on the Michigan Southern Railway, Oct. 1895, is described, giving profile of route and full details). Eng, Lond–March 27. 1100 w.

SCIENTIFIC MISCELLANY

Rontgen Rays Reflected.

TWO prominent American scientists have succeeded in reflecting these rays. Professor Ogden N. Rood, of Columbia University, in *Science* (March 27), and Mr. Nikola Tesla, in *Electrical Review* (March 18), claim to have demonstrated this property of the rays, and to have made good shadowgraphs by reflected Röntgen rays. Mr. Edwin B. Frost, of Hanover, N. H., also announces, in *Science* (March 27), that he has succeeded in "repeating Röntgen's reflection experiment, except that a celluloid film was used instead of a less permeable glass." In describing his experiments Professor Rood says:

"The apparatus employed was of the simplest character; a coil of moderate size, made by Ruhmkorff more than thirty years ago, was excited by a current suitable for class-room experiments, no condenser whatever being employed. The Crookes tube was of German make, and had originally been intended only for class demonstrations. With aid of a fluorescent screen, it had been carefully studied, and the best portion of it was employed. The reflecting surface consisted of a new sheet of ordinary platinum foil, which was held rather loosely against a plate of glass, no attempt being made to remove its accidental deformations, which were mainly parallel to the axis of the cylinder, which it had formed when rolled on its stick. These elongated deformations, convex and concave, were placed vertically."

Omitting Prof. Rood's description of the details of arrangement of plate-holder, etc., we quote further:

"After an exposure of ten hours, it was found that a good image of the netting had been produced on the vertical strip of the plate exposed to the reflected rays. This image had various deformations the vertical lines representing the netting being as a general thing most distinct; in some places, however, the horizontal lines had the upper hand, and there were a few spots where both were equally distinct. The image under those portions protected by two thicknesses of aluminum plate was perhaps a trifle fainter than that on the rest of the plate. These facts and the character of the deformations point very strongly to the conclusion that in the act of reflection from the metallic surface the Röntgen rays behave like ordinary light."

As a first approximation Professor Rood estimates that the platinum foil reflects a little less than $\frac{1}{360}$ of the rays.

Mr. Tesla, in his letter to the *Electrical Review*, states some very interesting facts, besides describing his reflection experiments. He says:

"I am producing strong shadows at a distance of forty feet; I repeat, forty feet and even more. Nor is this all. So strong are the actions on the film that provision must be made to guard the plates in my photographic department, located on the floor above,—a distance of fully sixty feet,—from being spoiled by long exposure to the stray rays. Though during my investigations I have performed many experiments which seemed extraordinary, I am deeply astonished in observing these unexpected manifestations, and still more so as even now I see before me the possibility, not to say certitude, of augmenting the effects with my apparatus at least tenfold. What may we then expect? We have to deal here, evidently, with a radiation of astonishing power, and the inquiry into its nature becomes more and more interesting and important. Here is an unlooked-for result of an action which, though wonderful in itself, seemed feeble and entirely incapable of such expansion, and affords a good example of the fruitfulness of original discovery. These effects upon the sensitive plate at so great a distance I attribute to the employment of a bulb with a single terminal, which permits the use of practically any desired potential and the attainment of extraordinary speeds of the projected particles. With such a bulb it is

also evident that the action upon a fluorescent screen is proportionately greater than when the usual kind of tube is employed. And I have already observed enough to feel sure that great developments are to be looked for in this direction. I consider Röntgen's discovery—the enabling us to see, by the use of a fluorescent screen, through an opaque substance—even a more beautiful one than the recording upon the plate.

"Since my previous communication to you, I have made considerable progress, and can presently announce one more result of importance. I have lately obtained shadows by reflected rays only, thus demonstrating beyond doubt that the Röntgen rays possess this property. One of the experiments may be cited here. A thick copper tube, about a foot long, was taken, and one of its ends tightly closed by the plate-holder containing a sensitive plate, protected by a fiber cover as usual. Near the open end of the copper tube was placed a thick plate of glass at an angle of forty-five degrees to the axis of the tube. A single-terminal bulb was then suspended above the glass plate at a distance of about eight inches, so that the bundle of rays fell upon the latter at an angle of forty-five degrees and the supposedly reflected rays passed along the axis of the copper tube. An exposure of forty-five minutes gave a clear and sharp shadow of a metallic object. This shadow was produced by the reflected rays, as the direct action was absolutely excluded, it having been demonstrated that, even under the severest tests, with much stronger actions, no impression whatever could be produced upon the film through a thickness of copper equal to that of the tube. Comparing the intensity of the action with an equivalent effect due to the direct rays, I estimate that approximately two per cent. of the latter were reflected from the glass plate in this experiment."

Mr. Tesla adds that he is finding increasing evidence to support the theory of moving material particles, and describes an experiment which he considers as positive proof that matter is expelled through the walls of the glass. In this experiment, if a small hole be made by the streamer produced by attaching a fairly-exhausted bulb to the terminal of a disruptive coil, air does not enter in at the opening; the interior pressure seems to be greater than the outside pressure of the atmosphere.

Another interesting observation made by Mr. Tesla is described by him.

"When working with highly-strained bulbs, I frequently experience a sudden, and sometimes even painful, shock in the eye. Such shocks may occur so often that the eye gets inflamed, and one can not be considered over-cautious, if he abstains from watching the bulb too closely. I see in these shocks a further evidence of larger particles being thrown off from the bulb."

Röntgen Rays in Sunlight.

WE may be surrounded by elements and energies of whose existence we have at the present time not the slightest suspicion. Two discoveries announced within a twelvemonth sustain the belief in this possibility. The finding of argon, and the accidental discovery that the Röntgen rays (X rays) represent a form of energy differing in important respects from any other form of energy known to us, have now been followed by the no less important discovery that no artificial source is necessary to develop the irrefrangible X rays, and that they exist nominally in the radiant energies of the sun. This discovery is announced by Dr. Charles S. Dolley and Dr. Seneca Egbert, in a preliminary note contributed to *Science* (March 6), an abstract of which is presented below. A supplementary note by the editor of *Science* states that "results somewhat similar to those given by Drs. Dolley and Egbert have been announced by M. Gustave Le Bon, Prof. S. P. Thompson, and others. The conditions are, however, so complex that it is difficult to eliminate sources of energy other than the Röntgen rays. Careful experiments at Columbia College have not detected any penetration of ($\frac{1}{100}$ inch) sheets of aluminum by sunlight, though ebonite and wood of considerable thickness are penetrated by ordinary light."

In the preliminary note upon which the editor's note just quoted is a comment, the authors describe their discovery and the circumstances under which it was made.

"Dr. Egbert was led on February 22 to place in a photographer's printing frame an ordinary sensitive plate (Seed's No. 26), upon which was superimposed a positive lantern slide, and on this a shield of aluminum; which was then exposed to the direct rays of the sun for two hours, and the plate developed, when it was found that the aluminum shield had been transparent to some agent which had produced a photographic effect, although the sensitive plate was completely in the dark within the printing frame, and thoroughly protected from light rays as generally understood. Apparently, however, the plate had been over-exposed, and it seemed that better results might be obtained by shorter exposures. Therefore, other plates of the same kind were exposed by us for gradually decreasing periods, under negatives and positives, and shields respectively of aluminum, hard rubber, black cardboard and double thicknesses of opaque needle paper.

"Positives were obtained in each case resembling those obtained by the photographer with ordinary methods, in some cases the exposures being as brief as ten minutes.

"Shadowgraphs ('skotographs' or 'skiagraphs') were also produced by the methods employed by Prof. Röntgen, except that the source of energy was the direct sunlight in place of the rays from a vacuum tube,—*i. e.*, coins placed upon the aluminum shield produced shadow prints on the sensitive plate.

"It is obvious that these experiments prove the presence in sunlight of the peculiar rays described by Prof. Röntgen, or of others possessing the same properties,—namely, the power of penetrating substances opaque to ordinary light rays.

"Prof. Röntgen states, in the second clause of his article (as translated and printed in *Science* of February 14, p. 227,) 'that some agent is capable of penetrating black cardboard, which is quite opaque to ultra-violet light, sunlight, or arc-light.' If this statement refers to sunlight *in toto*, including the visible and invisible rays, it is evidently contravened by our experiments, which demonstrate beyond a doubt existence of an 'agent' in sunlight which accomplishes the work of the 'X rays.'

"Prof. Röntgen refers to the possibility that the effect is due to a fluorescence produced in the material of the sensitive plate. One of our experiments seemed to point to the correctness of this hypothesis. Fixed photographic prints on albumen paper placed between the aluminum shield and the sensitive plate gave corresponding negative effects; but the space covered by these prints was evidently more intensely acted upon by the rays than other parts of the plate covered only by the aluminum. Should fluorescence be produced by these rays in silver emulsions, it would perhaps explain the phenomena. Prof. Röntgen further states that silver in 'thin' layers allows the rays to pass; but we have shown that some of the rays are partially stopped by the exceedingly thin film of silver in the ordinary photographic negative.

"It is obvious that the discovery of these rays in sunlight opens up an entirely new field for experiment, and is of the highest practical importance to all photographers."

This discovery has immensely widened the field of possibilities, both scientific and practical. That we are on the eve of other great discoveries, which will be likely to subvert some current hypotheses, seems extremely probable. Expectancy is the present attitude of the scientific world.

A Curious Fabric Made by Insect Larvae.

ONE of the most remarkable products of insect life yet discovered is described by Professor W. G. Johnson in the *American Miller* (April 1). Specimens of this fabric were obtained by Professor Johnson from Dr. Trelease, of the Shaw School of Botany, in St. Louis, and photographed; half-tone pictures of them accompany his description of them. Dr. Trelease, in a

letter quoted by Professor Johnson, says of these specimens that he obtained them from Dr. Francis Eschauzier, of San Luis Potosi, Mexico.

One of the specimens is described by Dr. Trelease as a "piece of thick, parchment like substance nearly three feet square, cut from a piece over twenty yards wide and about four times as long, manufactured by a worm on the ceiling of a corn-storing loft. The specimen is nearly white, and has much the appearance and feeling of a soft-tanned piece of sheepskin, but is marked with brownish stripes. As a rule, the surface is as smooth as that of a piece of dressed leather, but here and there dingy, fluffy masses are found which are easily removed, leaving abraded, rough places. While, as a whole, the membrane is continuous from one side to the other, and of nearly uniform thickness, there are places where, as Dr. Eschauzier had observed before the sending the specimen to me, as many as four distinct and more or less separable layers are observable. Throughout the specimen is perforated by many round or elliptical holes, from the size of a pinhole up to nearly a half inch in diameter, many of them more or less occupied by the dingy, fluffy material already mentioned as occurring in places on the surface."

Dr. Trelease, writing to Professor Johnson, says:

"A year later Dr. Eschauzier sent me two additional pieces of similar material, but of a gray color and of extreme tenuity, like the first, perforated by frequent holes. These specimens are comparable with the loose material observed here and there on the first specimen, but in continuity and uniformity of thickness they resemble the larger piece. At first all of the specimens emitted a strong odor of flour, as was to be expected, considering their source. These curious pieces of tapestry are composed of myriads of fine silken threads crossing and recrossing at every conceivable angle, and so producing the seemingly homogeneous texture. Unfortunately Dr. Eschauzier has not yet succeeded in obtaining specimens of the creatures by which they are produced, but there is no doubt that they are the work of lepidopterous larvæ which feed upon grain, and the presumption is that they are made by the larvæ of what is called the Mediterranean flour moth (Ephestia kuehniella)."

Professor Johnson says this specimen is truly a remarkable texture. He thinks the thickness is made up of layers, each generation of insects adding one layer. He estimates that there are one hundred and fifty layers, and that, if it be supposed that six generations of insects are produced annually, the "tapestry" was the work of from twenty to twenty-five years. Another specimen is thin and delicate, probably the work of one or two years. Except its thinness, its characteristics are the same.

Professor Johnson does not accept the opinion that these tapestries are the work of the Mediterranean flour moth. He says:

"In the first place, I have never known of an instance where the flour moth attacked stored grain. It is primarily a mill pest, and is usually found in the manufactured products, and not in the whole grain. I have, with difficulty, colonized it in whole grain (corn) in my laboratory, while on the other hand I have no trouble in breeding it in meal and flour. Another point to be considered in this place is the fact that the larvæ of the flour moth begin spinning just as soon as they hatch from the eggs, and that they trail this waste silk through their food until they are full grown, when they migrate to some isolated corner for pupation. During their migratory period, however, little or no silk is trailed. If we stop to consider the fact that the tapestries in question are formed on the ceiling of the granaries, and that the corn is stored below, we are led to conclude that the fabric is the product of an insect that is a prolific spinner during its migratory period, and that it colonizes readily in stored grain.

"We have such an insect, and it is popularly called the Indian meal moth. (Plodia interpunctella). This little moth has a great variety of food products, and has a wide distribution. It is a serious

pest to stored corn in many places, and has this year done much damage in stored grains in Central Illinois. When feeding in grain, the larvæ of this moth spin little, if any, silk during their growing period; but, when full grown, they leave their food, and crawl to some angle or corner, where they pupate. During this migratory period they spin very fine silken threads, wherever they go. Thus, when hundreds and thousands of the worms are crawling, a fine delicate fabric is soon constructed. I have a large colony of these creatures in my laboratory, and have repeatedly taken large pieces of silk of the finest texture from the tops of my breeding-cages. The sides of the cages are usually so thickly lined inside with this silk that I have some difficulty in seeing what is going on within. In my flour-moth cages I do not have any trouble, the silk being confined almost entirely to the flour or meal."

Cold Light.

UNDER this title, in *The Electrical World* (March 14), Mr. W. M. Stine discusses the economical transformation of energy into available power and cold light. This possibility has long been recognized, and much has been written upon it. Recently, however, the attention of the entire scientific world has been directed to the investigation of mysterious radiations whose existence, up to within a few months, has been barely more than suspected. A rapid accumulation of facts has resulted, and it seems as though a hitherto locked entrance to previously unknown avenues of research has been opened. To what discoveries this may lead no one can tell.

In animal organisms the fact that mechanical energy and light are produced by a consumption of substance almost incomparably less than has always been required for artificial power and illumination indicates that there are yet hidden methods of transforming energy of which we have not the slightest notion, except the one fact that they may exist. That in the researches into new forms of radiation we may stumble upon the key to these yet mysterious processes is a hope that renews interest in a somewhat hackneyed subject.

Touching the two surviving theories of light,—the electromagnetic, or ether-stress, and the mechanical, or ether-vibration, theories,—Mr. Stine says: "At present but one form of ether-wave has been positively proven to exist—the transverse. It was on this fact that the electromagnetic theory was based, and the unproven presence of longitudinal vibrations has been the most valid argument against the mechanical theory. Should investigations, now so universally carried on, prove with equal clearness the existence of longitudinal ether vibrations, the mathematical theory of light must needs be seriously modified, while the mechanical theory will be demonstrated beyond reasonable doubt. This matter has a most important bearing upon investigations on the production of cold light, since, if longitudinal vibrations exist, the ether must be considered granular, capable of at least minute condensation and rarefaction, and not as a perfectly rigid solid."

Mr. Stine expresses the belief that the artificial production of cold light will ultimately be reached, and intimates that the solution of the problem depends upon the discovery of means whereby a governable period can be given to molecular vibrations, and that the molecular vibrations must be established by direct means rather than by impact and direct collision. The only now-known direct means for transferring energy from a source to set up such vibrations are the electrical and magnetic methods.

Internal Temperature of the Earth's Crust.

A PRELIMINARY note of results of observations in the shaft of the Calumet and Hecla mine, by Professor Agassiz, who, aided by Mr. Preston C. F. West, engineer, has been taking observations at increasing depths reached in the mining operations, has been communicated to the *American Journal of Science*. He sums up the results as follows:

"We have, at the time of writing, attained at our deepest point a vertical

depth of 4,712 feet, and have taken temperatures of the rock at 105 ft.; at the depth of the level of Lake Superior, 655 ft.; at that of the level of the sea, 1,257 ft.; at that of the deepest part of Lake Superior, 1,663 ft.; and at four additional stations, each respectively 550 ft., 561 ft., and 1,256 ft. below the preceding one, the deepest point being 4 580 ft.

"We propose, when we have reached our final depth, 4.900 ft., to take an additional rock temperature, and to then publish in full the details of our observations. In the meantime it may be interesting to give the results as they stand. The highest rock temperaure, obtained at a depth of 4,580 ft., was only 79° F.; the rock temperature at a depth of 105 ft. was 59° F, Taking that as the depth unaffected by local temperature variations, we have a column of 4,475 ft. of rock with a difference of temperature of 20° F., or an average increase of 1° F. for 223.7 ft. This is very different from any recorded observations; Lord Kelvin, if I am not mistaken, giving an increase of 1° F. for 51 ft., while the observations based on the temperature observations of the St. Gothard tunnel gave an increase of 1° F. for 60 ft. The calculations based upon the latter observations gave a thickness of the crust of the earth, in one case of about 20 miles, the other of 26.

"Taking our observations, the crust would be over 80 miles, and the thickness of the crust at the critical temperature of water would be over 31 miles, instead of about 7 and 8.5 miles as by the other and older ratios. With the ratio observed here, the temperature of a depth of 19 miles would only be about 470°,—a very different temperature from that obtained by the older ratios of over 2,000° F. The holes in which we placed slow registering Negretti and Zambra thermometers were drilled, slightly inclined upward, to a depth of 10 ft., from the face of the rock, and plugged with wood and clay. In these holes the thermometers were left from one to three months. The average annual temperature of the air is 48° F.; the temperature of the air at the bottom of the shaft was 72°."

Curious Experience with Röntgen Rays.

KNOWLEDGE (April 1) publishes the following communication from Leon J. Atkinson, Arthur H. Pook, and R. P. Williams:

"While carrying out experiments with Röntgen rays, we have obtained results which we consider worth further careful investigation.

"On exposing a plate contained in an ordinary card-board plate-box with the object of obtaining a shadowgraph of keys, coins, etc., on the top, we failed to obtain the usual image; on exposing another plate in the same box, after a trifling alteration of apparatus, but with an entirely different series of objects, we obtained, on development, a well-defined image of the objects first exposed. Struck with this phenomenon, we made another exposure in the same box with a plate from a fresh packet, and, on developing, obtained a good image of the objects placed for the *second* exposure. We have repeatedly obtained these remarkable results under the following varied conditions:

"Exposure made and no result; box left for two days; fresh exposure made with entirely different objects, and resulting negative clearly defined objects placed in the box two days before.

"Exposure made and box exposed to strong daylight, to ascertain if sunlight would discharge the latent image, but with no effect. After an interval of eight days, the box was again subjected to X rays, and a negative obtained of objects exposed eight days previously.

"This is at present entirely inexplicable, and, as we only seem to get these retained or latent impressions with one box, we have not yet subjected the cardboard of which it is composed to more than superficial examination. It is our intention to endeavor to obtain more boxes of this particular batch, and, if, with these, we can confirm our present results, we hope to elaborate a theory which will account for what we can only now term 'the storage and transformation of images formed by X rays in certain undetermined varieties of cardboard.'

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

4739. Tesla on Röntgen Rays. Nikola Tesla (Illustration of results in radiography at great distances through considerable thicknesses of substance, with an account of investigations by the writer). Elec Rev–March 11. 2500 w.

4741. Sciagraphic Experiments. W. M. Stine (An account of investigations directed towards the character of the new radiant). Elec Eng–March 11. 2500 w.

4742. Manifolding by Cathode Rays. Elihu Thomson (An experiment made to test the effect of Röntgen rays in producing simultaneously a number of impressions of the shadow of the same object. Illustrated description). Elec Eng–March 11. 400 w.

4743. Stereoscopic Roentgen Pictures. Elihu Thomson (The desirability of such pictures, especially in surgical examinations). Elec Eng–March 11. 500 w.

4744. Shadow Pictures from the Arc and Sunlight. Ill. W. H. Freedman (Tests made which show that shadow photographs obtained by means of the arc and sunlight are not X-ray pictures). Elec Eng–March 11. 500 w.

4745. Electric Images without Crookes Tubes. Ill. R. K. Duncan (Describes experiment). Elec Eng–March 11. 200 w.

4746. Ultra Violet Rays and Lamps Adapted to Produce Them. Herbert Cottrell (Conclusions of the writer as to construction, with directions). Elec Eng–March 11. 700 w.

4765. Recent Experiments in Scientific Kite Flying (Illustrated description of the Hargrave kite, Lamson's multiplane folding kite, and Lamson's modified Hargrave kite, with experimental use of these kites. Abstract of article in Aeronautical Annual for 1896). Sci Am–March 14. 1800 w.

*4771. In a Flour Testing Laboratory (Describes the laboratory and the means and methods in use for testing the quality of flour). Milling–Feb. 1700 w.

†4773. The Medical Aspect of the Nicaraguan Canal. E. R. Stitt (Abstract of report to Bureau of Medicine and Surgery, from Surgeon-General Lyon's Report to the Secretary of the Navy. 1895. Treats of the diseases to which unacclimated persons and natives are liable in the region, their causes and their prophylactic and remedial treatment). San–March. 6000 w.

†4786. Chemistry of the Berea Grit Petroleum. Charles F. Mabery and Orton C. Dunn (Besides a description of the results obtained by chemical analysis of petroleum, the region named and the geology of the oil-bearing strata is discussed). Am Chem Jour–March. 4800 w.

*4793. On the Chromogeneous Top. Charles Henry (An explanation of apparitions, produced by the rotation of the top and of the inversion of the order of their arrangement when the direction of rotation is reversed). Engng–March 6. 1000 w.

4804. Expe iments with Röntgen Rays. Alexander Macfarlane (Illustrated description of experiments made in the electrical laboratory of Lehigh University). Elec Wld–March 14. 1000 w.

4806. Cold Light. W. M. Stine (A consideration of the great waste of all forms of artificial illumination, and the problem of the controllable production of light. The writer considers the ultimate accomplishment almost a certainty). Elec Wld–March 14. 2500 w.

*4809. The X-Rays and the New Photography (A review of experiments and discoveries of various investigators in this field). Elec Rev, Lond–March 6. 2500 w.

*4810. The New Photography. Richard C. Shettle (An experiment which appears to determine that the cause of the phenomena which Prof. Röntgen was the first to discover, is the direct result of electric stress, and not as was supposed, of invisible light). Elec Rev, Lond–March 6. 900 w.

4821. Tesla's Latest Results in Radiography (Letter from Nikola Tesla. He now produces radiographs at a distance of more than forty feet). Elec Rev–March 18. 1300 w.

4822. Note on the Use of Acetylene Gas as an illuminant for Polariscope Work H. W. Wiley (Contributed by the Chemical Laboratory of the U. S. Dept. of Agriculture, to the Washington Section of the Amer. Chem. Soc). Pro Age–March 16. 800 w.

4825. An Acetylene Standard for Photometry (Translation of a paper by M. Violle in *Comptes Rendus*. Acelytene is considered as possessing certain advantages as a photometric standard). Pro Age–March 16. 500 w.

4826 An Inexpensive Photometer. *From Electrical Industries* (Illustrated description of a form of photometer, suggested by E. P. Roberts, which is cheap, and, it is claimed, gives satisfactory results). Pro Age–March 16. 900 w.

4827. The Manufacture of Cut Glass. Charles H. Garlic (Illustrated description). Safety V–March. 3000 w.

4831. Preparation of Lamb and Kid Skins for Gloves (Illustrated description of appliances and processes). Sci Am–March 21. 900 w.

4840. Röntgen Rays from the Anode Terminal. Elihu Thomson (Experiment showing that the rays proceed from the anode). Elec Eng–March 18. 700 w.

4844. Edison's Röntgen Rays Experiments. Edwin J. Houston and A. E. Kennelly (An interesting résumé of the result of Mr. Edison's experiments to date on Röntgen rays. The most notable conclusion reached is that there is no apparent advantage in obtaining a very high vacuum in the ray lamp and a criterion is given by means of which the proper degree of vacuum may be recognized). Elec Wld–March 21. 1300.

We supply copies of these articles. See introductory.

*4854. Engineers—Consulting, Inspecting, Contracting. George W. Dickie (Not an exhaustive treatment with respect to any of the points discussed, but intended rather to draw out a general expression from members of how these questions have affected them in their practice). Jour Assn Eng Soc–Feb. 7000 w.

4859. The Use of Logarithms. C. K. Jackson (Gives instructions in the use and application of logarithms in abbreviating arithemetical and algebraic operations). Am Mach–March 19. Serial. 1st part. 1500 w.

†4928. Facts and Figures Regarding Our Forest Resources Briefly Stated. B. E. Fernow (Forest area, character of forest growth, amount of standing timber ready for cutting, value, exports, imports, uses of timber in the arts, centers of production and many other interesting topics are treated in this circular). U S Dept of Agriculture Circ No 11. 3500 w.

*4940. The New X-Ray "Focus" Tube (Illustrated description of a tube for producing X-rays which is said to be a great improvement on anything in this line that has been previously produced). Elec Rev, Lond–March 13, 700 w.

*4941. Electricity a Mode of Motion.—The Röntgen Rays. What Are They? Sydney F Walker (The writer considers the Röntgen rays to be electrical waves under very high tension, and their action is due to their conversion into light waves, etc). Elec Eng, Lond–March 13. 1300 w.

*4950. The Tobacco Industry of India and the Far East. C. Tripp (The conditions necessary for the production of high class tobacco are considered, and the special conditions of the regions named. The paper is followed by a discussion). Jour Soc of Arts–March 13. 14000 w.

*4951. The New Photography by Cathode Rays. John Trowbridge (Illustrated description in popular style. Gives application of the new photography to surgery, by a method of locating the exact position and depth of a bullet by triangulation). Scrib Mag–April. 2400 w.

4953. Experiments with Roentgen Rays. Thomas A. Edison (Investigations on fluorescing salts, and experiments with vacuum tubes). Elec Eng–March 25. 600 w.

4954. Roentgen Rays "Anodic" not "Cathodic." Elihu Thomson (Experiments made by the writer to determine whether the rays are emitted from the cathode or anode). Elec Eng–March 25. 1300 w.

4955. The Spectra of the Bunsen Burner and Exhausted Bulbs. W. H. Birchmore (Interesting investigations of light). Elec Eng–March 25. 2300 w.

4956. Shadow Pictures by Arc Light Rays. W. W. Ker (Experiments made which add a few facts concerning the production of X-rays). Elec Eng–March 25. 700 w.

4958. Roentgen Rays. Max Osterberg (Abstract of a lecture delivered before the New York Elec Soc). Elec Eng–March 25. 2800 w.

4964. On the Generation of Longitudinal Waves in Ether. Lord Kelvin (Paper read before the Royal Society. Showing an arrangement by which a large space of air is traversed by waves essentially longitudinal). Elec–March 25. 1200 w.

*4975. The Cathode Ray,—Its Character and Effects. A. W. Wright (Historical sketch of the steps leading up to the discovery of the cathode ray, and a general summary of the present state of knowledge with respect to its nature). Forum–April. 2200 w.

4995. State Engineering Experiment Stations. J. P. Jackson (Explains the provisions of a bill now before Congress, having for its object the promotion by annual grants of money from the national treasury, of scientific investigation, engineering research and experimental testing at the various State colleges which are beneficiaries of the Land Grant Act of 1862). Elec Wld–March 28. 1100 w.

4998. Theories of the Röntgen Rays. W. M. Stine (The hypotheses of the nature of the rays already advanced, and pointing out fallacies). Elec Wld–March 28. 1200 w.

4999. The New Marvel in Photography. Ill. H. J. W. Dam (A visit to Prof. Röntgen at his laboratory in Würzburg. His own account of his great discovery. Interesting experiments with the cathode rays. Practical uses of the new photography). McClure's Mag–April. 4800 w.

5000. The Röntgen Rays in America. Cleveland Moffett (A review of work by Arthur W. Wright, William J. Morton, W. L. Robb, M. I. Pupin, Thomas A. Edison, etc., with illustrations). McClure's Mag–April. 3300 w.

5001. Sciagraph of Sheep's Brain (Experiments of John Kammer of Chicago are described). W Elec–March 28. 500 w.

5006. On the Reflection of the Röntgen Rays from Platinum. Ogden N. Rood (Describes experiments made by writer). Science–March 27. 700 w.

5007. Further Experiments with X-Rays. Edwin B. Frost (Experiments made at the Dartmouth Laboratory). Science–March 27. 1300 w.

*5010. The New Photography. Charles Barnard (Popular explanation aiming to show the value and import of Prof Röntgen's discoveries). Chau–April. 3000 w.

*5032. The Sisal Industry in the Bahamas. D. Morris (A very full account of the entire industry, including a botanical description of the plant, methods of extracting the fibre, etc., with discussion). Jour of Soc of Arts. March 20. 10000 w.

†5061. The Röntgen Rays. Edwin J. Houston and A. E. Kennelly (This paper gives a résumé of facts known concerning Röntgen's discovery, and some of the theoretical explanations of the X-rays that have been offered. The discussion following the reading of the paper is of much more than usual interest, having been participated in by many learned scientists, and presenting some facts of personal experience, that have not hitherto been generally known). Jour Fr Inst–April. 14500 w.

We supply copies of these articles. See introductory.

†5070. The Practical Results of Bacteriological Researches. George M. Sternberg (Address of the president of the Biological Society of Washington, delivered Dec. 14, 1895, under the auspices of the joint Commission of the Scientific Societies of Washington. A résumé of progress in bacterial research from its beginning down to present date). Pop Sci M–April. 6500 w.

†5071. The X-Rays. John Trowbridge (A general dissertation in which the author is forced to conclude that in this phenomenon we are brought closer to a wave theory in a medium han in a molecular theory of movement of matter). Pop Sci M–April. 2300 w.

5087. The Manufacture of Paper (Description of materials and processes employed in paper manufacture). Sci Am–April 4. 1500 w.

5089 The Edison X-Ray Experiments, Apparatus and Fluoroscope (Illustrated description indicating mode of application to surgical examinations). Sci Am–April 4. 1100 w.

5091. Röntgen's Rays (A collection of opinions, experiments, explanations, and experiences of eminent scientists, given under various headings). Sci Am Sup–April 4. 5400 w.

5092. Acelytene Apparatus. T. O'Conor Sloane (Illustrated detailed description of apparatus and method of using it). Sci Am Sup–April 4. 2800 w.

5093. The Porcelain Works at Meissen (An exceedingly interesting description, with excellent and numerous illustrations of processes in various stages). Sci Am Sup–April 4. 2200 w.

*5108. Metric System of Measurements Demanded (An argument against the adoption of the metric system in the United States. It is alleged that its advocates are mostly college teachers and enthusiasts who do not realize at what cost a change of measurements would be effected). Loc Engng–April. 1800 w.

5112. Opaque Objects Made Transparent by Rays Passing through Chemical Solutions (An account of an alleged remarkable discovery, by Mr. A. G. Davis, of Parkersburg, consisting of an arrangement of chemical solutions, the effect of which is to make opaque bodies transparent to light). Elec Eng–April 1. 500 w.

5115. On the Sensitiveness of Certain Salts to the X Rays. Thomas A. Edison (Brief description of the writer's recent researches on the fluorescence of metallic salts). Elec Rev–April 1. 500 w.

5116. Edison's Fluoroscope (Illustrated description of a device that promises to be of great value to the medical profession). Elec Rev–April 1. 600 w.

5117. Tesla on Reflected Roentgen Rays (A communication from Nikola Tesla regarding results obtained by means of his apparatus, giving tests and investigations of the reflective power of conductors). Elec Rev–April 1. 3000 w.

5136. Statues and Monuments of New York. N. Macdonald (A critical description of the statues erected in New York, with names of artists and points of interest regarding them). Arch & Build–April 4. Serial. 1st part. 2500 w.

5140. Electrographs. Walter H. Merrill (Illustrated account of experiments tending to show that good results can be obtained by using the electricity obtained from a charged driving belt, or any similar source, provided the connections are properly made). Elec Wld–April 4. 600 w.

5142. The Surgical Value of the X-Ray. James Burry (A consideration of the Röntgen rays only from the surgeon's point of view). W Elec–April 4. 1400 w.

5143. On the Source of the Röntgen Ray. W. M. Stine (Experiments which the writer claims show that there is but one marked source of the ray, that portion of the bulb opposite the cathode, and that the entire surface of the bulb is more or less a weak secondary force). W Elec–April 4. 1100 w.

5144. The Source of the X-Ray. C. E. Scribner and F. R. McBerty (Experiments with pin-hole images seeming to prove that the rays proceeded only from the bombarded spot at the inner wall of the tube opposite the cathode). W Elec–April 4. 1800 w.

5150. Directory of Engineering Societies (Gives not only names and addresses but also places and dates of meetings and names of secretaries for all engineering societies in the United States and Canada). Power–April. 3700 w.

†5166. A Theory of the "X-Rays." Albert A. Michelson (The theory of longitudinal waves, and theory of projected particles, are enunciated and their difficulties stated. The author then presents a third theory which he calls the "ether-vortex" theory, by which he seeks to explain the production of the rays by electric impulse at the cathode, in a highly exhausted enclosure; the propagation of the rays in straight lines; absence of interference, reflection, refraction and polarization; the importance of the density of the medium, as the determining factor in transmission of the rays; the production of fluorescence and actinic effects, and the action of the rays on electrified conductors. In this theory the X rays are considered as vortices of an intermolecular medium). Am Jour of Sci–April. 1000 w.

†5167. The Variation of the Modulus of Elasticity with Change of Temperature as Determined by the Transverse Vibration of Bars at Various Temperatures. The Acoustical Properties of Aluminum. Alfred M. Mayer (Read before the British Association, at Oxford. An important and laborious research is described, which is accompanied by extensive tables of data. Many diagrams, illustrating by the graphic method variations of the modulus of elasticity at various temperatures, etc., and engravings, illustrating descriptions of apparatus and methods). Stev's In–April. 6000 w.

†5169. Roentgen Rays. Henry Morton (States facts which explain the true character of Röntgen's discovery and the mixed or uncertain character of many experiments recently made by others. Prof. Morton says that many experimenters who have been producing shadowgraphs

with sunlight, electric lights, and the like have not been repeating Röntgen's operations but only applying facts known for fifteen years or more). Stev's In-April. 2400 w.

†5170. Heating Value of the Volatile Portion of Bituminous Coal. William Kent (Suggestions to any one who may be disposed to undertake a research of this kind. The research will involve much labor but will supply answers to the following questions. (a) What is the character of the volatile matter of the more highly bituminous coals? (b) May it not be commercially possible to get rid of the least valuable products at the mines by some kind of coking process?). Steven's In-April. 1600 w.

†5172. Practical Photometry. Alten S. Miller (The Bunsen photometer is illustrated and described and a mode of using it effectively is set forth). Steven's In-April. 2800 w.

†5173. Novel Experiments with X-Rays. Edward P. Thompson (Successful experiments directed to the determination of the possibility of applying X-rays to the discovery of movements of hidden objects). Steven's In-April. 900 w.

*5174. Silk Fabric Made by Insect Larvæ. W. G. Johnson (Describes and illustrates a most remarkable fabric made by an insect not yet determined, one of the specimens being a piece about three feet square, cut from a piece twenty yards wide and nearly four times as long, manufactured on the ceiling of a corn-storing loft). Am Miller-April. 1600 w.

*5175. Fires in Flour Mills During 1895 (Despite the favoring conditions resulting from depression in trade, which increases the moral hazard, these statistics show no material increase in mill fires for the year. A table of fires for 1894 and 1895 is presented, with other interesting details). Am Miller-April. 1600 w.

5188. Brickmaking in Tuskegee, Ala., Industrial School. Victoria Earle Matthews (Illustrated description of the industry and some of the buildings erected with these bricks). Brick-April. 1200 w.

*5191. The Classification of Physical Experiments. E. E. Fournier-D'Albe (The object of the paper is to specify the characteristic types of experimental elements, and to find a simple and comprehensive classification and notation for the various physical experiments). Elect'n-March 27. 2200 w.

*5200. How to Photograph and See Through Opaque Bodies. E. Andreoli (Illustrated description of apparatus recommended by Messrs. Ducretet and Lejeune whereby electrical students, medical men, etc., can produce X-rays without the installation of an alternator, &c.) Elec Rev, Lond-March 27. 1100 w.

5202. Professor Enrico Salvioni's Work on the X-Ray. Salvatore Cortesi (An interview with this eminent scientific man at the University of Perugia, Italy). Elec Rev-April 8. 2500 w.

5203. Tesla on Roentgen Radiations (An account of recent work accomplished. The time is reduced and the distance is four feet). Elec Rev-April 8. 2000 w.

5206. Are Roentgen Ray Phenomena Due to Sound Waves? Thomas A. Edison (An account of experiments with comments, and a reproduction of the article referred to). Elec Eng-April 8. 1300 w.

5207. The Roentgen Ray Source. Elihu Thomson (Correcting the statement made by the writer that the anode was the source of the rays). Elec Eng-April 8. 700 w.

5208. I. Centralizing X-Ray Bulb. II. External Electrodes Vacuum Bulb. Ill. William James Morton (Experiments explained). Elec Eng-April 8. 800 w.

5209. Phosphorescence as the Source of X-Rays. Edward P. Thompson (Experiments that give substantial evidence that X-rays are not obtained from phosphorescence by sunlight). Elec Eng-April 8. 1700 w.

5211. M. de Morgan's Discoveries at Dahshur. (Illustrated description, reprinted from *Illustrated London News*. The specimens of ancient Egyptian gold-smith work illustrated are a most interesting addition to specimens of ancient handiwork and to the history of ancient art). Sci Am Sup-April 11. 1900 w.

5212. Intermittent Springs. Walter C. Garretson. (A new theory, which the writer thinks confirmed by experiments which he describes). Sci Am. Sup-April 11. 1200 w.

5213. Increase of the Photographic Yield of the Roentgen Rays by Means of Phosphorescent Zinc Sulphide. Charles Henry. (Describes experiment proving that by coating with phosphorescent zinc sulphide bodies capable of absorbing Röntgen rays, it is possible to render visible on the photographic plate, objects situated behind such bodies, and otherwise invisible). Sci Am Sup-April 11. 1100 w.

5214. On a Mechanical Action Emanating from the Crookes Tube Analogous to the Photographic Action Discovered by Roentgen. Messrs. Gossart and Chevalier. (Note communicated to *Comptes Rendus*. The view is expressed that this may be a point of departure for a series of researches which the writers hope to pursue—the study of the field of the Crookes tube with the radiometer). Sci Am Sup-April 11. 800 w.

†5226. Rivers of the South American Rubber Country. Hawthorne Hill. (An account of the badly obstructed rivers of this region, and the benefits to trade—especially in crude india-rubber—that would follow the overcoming of these difficulties in transportation). Ind Rub Wld-April 10. 1000 w.

†5227. Condition of the Rubber Trade in Chicago. (An interesting letter on the growth and prosperity of this industry). Ind Rub Wld-April 10. 2500 w.

†5228. Changes in the New York Rubber District. (Review of interesting history of some of the large rubber houses, with notices of removals to larger and better quarters). Ind Rub Wld-April 10. 1000 w.

†5229. Single-Tube Tires and the Tillinghast Patents (An article of interest to bicycle manufacturers. A review of the whole subject). Ind Rub Wld-April 10. 2200 w.

We supply copies of these articles. See introductory.

COMMENT & CRITICISM

The Engineering Index.

I NOTED your adverse comments last fall, on a suggestion made by one of your readers, that the index to current engineering literature be printed on one side of the sheet only, and placed in the back of the volume. It may be quite true that the number who would now make use of the same for card-indexing is limited, but the fact remains that there is an increasing demand for means of reference to the scattered articles on engineering subjects, to which fact your very complete index bears ample testimony.

Might I suggest that the index be printed among the advertising pages, using one side of the page for advertising matter, and the other for the index, in the same style as formerly followed by the *Journal of the Association of Engineering Societies*, but with the improvement of having the articles classified. I see no reason why this should incur additional expense in publication, while it should increase the value of the advertisements. In this form, your readers could detach the pages without mutilating the magazine, and could mount them on the card index, or classify them by any desired method.

As at present arranged, the index appeals to me as an exceedingly valuable feature of your publication; but I sincerely trust that some alteration can be made, whereby your readers may be enabled to arrange the sheets, so as to give them a permanent instead of a passing value.

ARTHUR S. TUTTLE.

Brooklyn, April, 1896.

[AN insuperable objection to Mr. Tuttle's suggestion is the obvious fact that such an arrangement would give our pages the unmistakable appearance of an advertising sheet. The practice of interlarding advertisements with reading matter, and the wholesale insertion of "write-up" matter in the editorial pages of industrial journals, may be fitly described as a nuisance. Engineering journalism can never hope to attain that degree of potent influence and material prosperity which is possible, until every taint of advertising is rigidly excluded from editorial pages.

Mr. Tuttle, and doubtless many others of our readers, will be gratified to learn, however, that it is a part of our plan to reissue our monthly index in the form of a regular annual volume. The aim will be to have it cover the entire range of English and American engineering literature, for each calendar year from January to December, and to have the work so thoroughly classified and so conveniently arranged that it may serve as a complete and ready reference to everything of value published during the year. In short, the idea will be to issue such a volume as will remove the necessity for card indexes of all kinds.

Volume II of THE ENGINEERING INDEX, covering the four years to January 1, 1896, will be issued this month, thus completing the splendid work which the Association of Engineering Societies has carried on for the past eleven years. We shall now take up the work where they left off, and the annual volumes will appear regularly, as above mentioned.—THE EDITOR.]

Fires From Steam Pipes.

I NOTICE in the December number of THE ENGINEERING MAGAZINE some instances of danger from steam-heating apparatus.

I want to add two cases which occurred in Washington, and within my own knowledge. One was the Corcoran building, opposite the Treasury, which took fire from the steam pipes at night; the fire was discovered and extinguished before any serious damage occurred. The other was

a private dwelling near my own. In this a low-pressure steam-heating apparatus had been placed but a few weeks before. The boiler was set in a room a little lower than the other rooms of the basement, and one steam supply pipe and two return pipes were run alongside of each other under the floor of the adjoining room, on the ground. The floor took fire where these pipes were assembled, and the flames came near destroying the house. That very season, a party engaged in putting in steam-heating apparatus here was stating in the papers that it was impossible to set wood on fire by steam pipes.

There is no question that steam-pipes generate fire in wood under suitable conditions, whether they are covered or exposed, especially when situated where lint and dust will accumulate upon them. In the case of wood and similar material, the wood in the course of time becomes charred, and ultimately takes fire, like charcoal. Too much care cannot be taken to prevent this. Much better have the pipes exposed than cover them, unless with incombustible material; and in no case should they be run in contact with joists, flooring, or any wood work without thorough protection. Now that steam heating is becoming so common, even in private residences, this matter deserves careful attention. W. C. DODGE.

Washington, April, 1896.

Telephones for Trolley Cars.

IN your February issue, page 943, you refer to an installation of telephones on a line of street railway. About the same time the writer was experimenting with telephones, and he has now equipped the Bangor, Orono, and Old Town Railway with a system which we consider far superior. We run an iron wire by the side of the trolley over all the road; where bracket work is used, the wire is on the poles. The telephone is on the car in a small box. When delayed, the conductor swings the trolley-pole to the iron wire, and, by pressing a key, calls the office for instructions. You can readily see the advantage of such a system over the one mentioned in the article referred to. This line is in daily operation. I. L. MELOON,

Supt.

Bangor, Me., April, 1896.

Due Credit to Mr. Grimshaw.

REFERRING to the statement of Mr. Outerbridge in the December issue of THE ENGINEERING MAGAZINE, that the mechanical handiwork schools of the Spring Garden Institute, Philadelphia, were established (soon after the famous Russian exhibit at the Centennial Exposition) under the supervision of Lieut. Crawford of the Navy, Mr. Addison B. Burk, president of the Institute in question, states that they were established in the fall of 1879 by Dr. Robert Grimshaw; that the first class was organized January 26, 1880; and that Lieut. Crawford, being detailed to the Institute in the fall of 1882, reorganized the classes. RECORD.

Philadelphia, March, 1896.

Mr. Atkinson and His Critics.

I AM very much gratified by the newspaper slips that you have sent me, especially the abusive comments, from some of the silver States, upon my recent article on "Jingoism."

I am reminded of a previous experience of this kind. Either by the error of my stenographer, or that of a printer's devil on one of the western papers to which I sent a letter, two dates affecting the silver question were transposed, and I therefore appeared to state what was not true historically. Upon this, the editor of the Denver *Republican* wrote and sent me a marked editorial to this effect: "Edward Atkinson is the champion liar of the world—the most accomplished one that ever lived. Ananias was very discreet in getting himself born early in history, for, if he had waited until now, he would have had no reputation compared to Atkinson." To this I replied by letter, which, of course, was not printed, somewhat in these words: "I value such editorials as that you have kindly sent me. They always go into my scrap-book, because they prove that I have hit the mark. My rule in discussing free coinage is, wherever I

see a silver head, hit it; and I am rejoiced to have the evidence in this case that I have cracked a skull empty of everything except courtesy."

EDWARD ATKINSON.

Boston, March, 1896.

Steam Boiler Efficiency.

PLEASE allow me to offer the following in regard to your review, on p. 759 of your January number, of an article by Mr. Westerbaan Muserling on steam boiler efficiency in *Engineering* (Nov. 1):

Let g=sq. ft. of grate surface in any boiler
h= " " " heating surface
c=pounds of coal burned per hour
w= " " water evaporated per hour

then—$\frac{c}{g}$=pounds of coal per sq. ft. of grate surface per hour (*a*)

$\frac{w}{c}$=pounds of water per pound of coal (*d*)

$\frac{h}{g}$=sq. ft. of heating surface per sq. ft. of grate surface (*b*)

$\frac{w}{h}$=pounds of water per hour per sq. ft. of heating surface (*c*)

then, according to the rule given,

$$a.d=b.c$$

or, using our equivalents,

$$\frac{c}{g}.\frac{w}{c}=\frac{h}{g}.\frac{w}{h}$$

and, cancelling like factors in numerators and denominators,

$$\frac{w}{g}=\frac{w}{g}$$

Of course it does; and you will see that, as each quantity is used twice in such a way that it neutralizes itself, any or all of them might be wrong to any extent without affecting the equality.

In the light of the above, I would like to ask you why you consider the agreement in these various tests so surprisingly close. What have the inaccuracies to do with experimental errors? Would it not be as pertinent to prove experimentally that, because twice three is six, one-half of six will be three in the generality of cases?

GEO. H. TABER, JR.

New York, March 23, 1896.

[This application of the Heuett's chain rule was similarly criticised in *Engineering*, subsequent to its publication. Our tacit approval of its usefulness in the review referred to was due to great confidence in the source from which the article was selected. This led to its publication without a critical examination, which would have shown the weakness plainly indicated in Mr. Taber's criticism.—EDITOR.]

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

S. Wilks Manufacturing Co., Chicago, Ill., U. S. A.=Catalogue. Illustrating and describing a remarkably fine line of hot-water heaters, steam generators, steam tanks, etc., for hotels, dwellings, greenhouses, laundries, churches and baptisteries, bath houses, carriage houses, etc., etc. This line of goods represents a great variety of high-class heating appliances, constructed of steel and adapted to numerous purposes in domestic engineering.

Buffalo Forge Co., Buffalo, N. Y., U. S. A.= Illustrated Sectional Catalogue of the Buffalo Horizontal and Upright Engines. Including in descriptions side-crank and self-contained horizontals with throttling governors, center-crank automatic cut-off horizontals, double and single automatic cut-off uprights, etc., for electric lighting and general refined service. First catalogue issued by this company devoted entirely to engines, and is presented in the elegant form characteristic of all its trade publications.

The Fairbanks Co., New York, U. S. A.=Illustrated Catalogue and Price-List of hand, platform, and dry goods trucks, and express and baggage barrows.

Royal Electric Co., Peoria, Ill., U. S. A.= Illustrated Catalogue of Electrical Machinery for light and power.

Merchant & Co., Incorporated, Philadelphia, New York, and Chicago, U. S. A.=Pamphlet entitled "Overhead." Describes and illustrates artistic metal roofing with engravings of important buildings upon which such roofing has been placed.

The Jeffrey Manufacturing Co., Columbus, Ohio, U. S. A.=Catalogue, No. 43. Describes and illustrates chain belting, elevators, conveyors, carriers, power-transmission machinery, etc.

The John F. Byers Machine Co., Ravenna, Ohio, U. S. A.=Catalogue. Illustrates and describes latest and best style of hoisting machinery, including hoisting engines, boilers, derrick irons, hand powers and elevators, and a line of contractors' and builders' supplies.

Boston Belting Co., Boston and New York, U. S. A.=(*a*) Catalogue illustrating and describing a complete line of garden hose, and hose appliances for gardeners' use. (*b*) Catalogue and price list of fire hose, and hose appliances, test pumps, hose racks, couplings, etc.

Translucent Fabric Co., Quincy, Mass., U. S. A.=Pamphlet entitled "Translucent Fabric," describing the flexible, durable, and unbreakable substitute for glass manufactured by this company for skylights, office doors, and all purposes where glass is likely to be broken. These various applications are explained, with the aid of engravings, in a very concise and clear way.

American Blower Co., Successor to Huyett & Smith Mfg. Co., Detroit, Mich., U. S. A.= Pamphlet entitled "Speaking About Bricks," illustrating the "A B C" progressive brick dryer for drying brick, tile, terra cotta, etc. The subject of brick drying is treated scientifically and practically in this well-written and interesting pamphlet, which also contains testimonials from users warmly commending the apparatus.

Lidgerwood Manufacturing Co., New York, Boston, and Chicago, U. S. A.=Large pamphlet illustrating and describing hoisting and conveying devices. The engravings are very numerous and well-executed, and illustrate examples of apparatus in use at many places, and for a variety of work.

J. S. Mundy, Newark, N. J., U. S. A.=Pocket Catalogue of high-class hoisting, bridge erecting, pile-driving, bogging, mining, and quarry machinery, mud dredging engines, steam boilers, etc.

Otto Goetze, representative in the United States of Ed. Muller & Mann, Charlottenburg, Germany.=Pamphlet describing "Manocitin" for protecting iron and steel from rust, and preventing corrosion and rust upon anything liable to be injured in this way when exposed to atmospheric influences.

Milne Manufacturing Co., Monmouth, Ills., U. S. A.=Catalogue illustrating and describing grub and stump machines, and other appliances for clearing timber land.

Lidgerwood Manufacturing Co., New York, Boston, Chicago, U. S. A.=Pamphlet beautifully illustrated in half-tone entitled "Logging by Steam." Describes improved systems under the patents of Butters, Baptist, Beekman, Miller, and Dickinson.

Link-Belt Engineering Co., Philadelphia and New York, U. S. A.=Elegantly printed and illustrated catalogue, describing modern methods of mining, and handling coal, minerals, etc.

American Injector Co., Detroit, Mich., U. S. A.=Catalogue for 1896. Illustrates and describes a line of injectors, ejectors, jet-pumps, drive-well jet-pumps, exhaust injectors, fire plugs, grease-cups, etc.; also contains data useful to engineers.

American Boiler Co., New York, Chicago, U. S. A.=Elegantly printed and illustrated catalogue describing the "Florida" hot water and steam heating boilers, and hot water and steam heating apparatus, with lists of sizes, capacities, etc.

William Sellers & Co., Philadelphia, Pa., U. S. A.=Leaflet, illustrating and describing new centrifugal sand-mixing machine, the method of using it, and its great advantages.

The Q & C Co., Chicago, Ill., New York, N. Y., Atlanta, Ga., Boston, Mass., St. Paul,

Minn., U. S. A.=Leaflet entitled "Extract from the Engineering Magazine,"—a plain, pointed, and practical statement of the usefulness in shops of this excellent device.

National Pipe Bending Co., New Haven, Conn., U. S. A.=Pamphlet illustrating and describing the "National" feed-water heater, with details and dimensions, method of setting, table of percentage of fuel saved by its use, etc.

Ross & Co., London, Eng.=Abridged price list of articles for photo outfits.

H. W. Johns Manufacturing Co., New York. =Pamphlet entitled "Atlanta Exposition Locomotive Exhibits." Examples of locomotive boilers lagged with the asbestos cement manufactured by this firm.

General Fire Extinguisher Company, Providence, R. I., U. S. A.=United States Sprinkler Bulletin, January 31, 1896. A quarterly trade publication issued by this company, which sets forth the advantages of fire-extinguishing devices, instances where they have been effective in putting out fires, and general information relating to fires.

The Watson and Stillman Hydraulic Machinery Works, New York, U. S. A.=Catalogue of hydraulic jacks, hydraulic presses, pumps, valves, gages and fittings, punches, shears, etc., with illustrations, directions for use, price lists, etc.

Lidgerwood Manufacturing Company, New York, Chicago, and Boston, U. S. A.=Pamphlet, 72 pages. Elegantly illustrated in half-tone. "Contractors' Methods Employed on the Great Chicago Drainage Canal." A most interesting and instructive compilation, incidentally illustrating the uses and advantages of the traveling cableways manufactured by this company. A model trade publication.

Jones and Lamson Machine Co., Springfield, Vt., U. S. A.=Pamphlet, 79 pp. (with large infolding plate), entitled "Rapid Lathe Work." Describes and illustrates in detail the "Hartness," a flat turret lathe, gives a list of 350 of these machines in use in large establishments, and is altogether a very fine trade publication. The infolding plate shows samples of work done on this lathe, and gives brief descriptions of the methods for producing them.

T. H. McAllister, New York, U. S. A.= Condensed list of optical goods.

Buffalo Forge Co., Buffalo, N. Y., U. S. A.= (a) Leaflets describing and illustrating "Buffalo" blacksmiths' drills Nos. 60, 66 and 68, and other blacksmiths' tools and appliances. (b) Leaflet describing and illustrating a new "Buffalo" steel plate bellows forge for bridge-builders, boiler makers, and structural iron workers.

Fraser & Chalmers, New York, U. S. A., Denver, Colorado, U. S. A., Chicago, U. S. A., Salt Lake City, Utah, U. S. A., and London, Eng.=Catalogue, 180 pp., illustrating and describing a long line of gold and silver mills, and other metallurgical machinery and apparatus. An admirable work of very great value to every one concerned with modern and economic mining operations.

F. Weber & Co., Philadelphia, Pa.=Catalogue of Architects, Engineers, and Draughtsmen's Supplies.

The New Britain Machine Co., New Britain, Conn., U. S. A.=Illustrates and describes chain-saw mortisers and the Case steam engines manufactured by this company.

The Colorado Iron Works, Denver, Colorado, U. S. A.=Pamphlet, containing important information relating to ore-crushing machinery for concentration, amalgamation, cyanide and chlorination plants.

Diamond Machine Company, Providence, R. I., U. S. A.=Catalogne of Diamond Grinding Machinery for all Metals, with index to other catalogues illustrating and describing lines of grinding machines for a great variety of special purposes.

Beaman & Smith, Providence, R. I.=Catalogue of machine tools, special machinery, etc.

Staples, George S. Annual Report of the Commissioner of Streets of Portland, Me. Williams M. Marks, printer, Portland, Me. 1895.

Fernald, George N. Annual Report of the City Engineer of Portland, Me. William M. Marks, printer. Portland, Me. 1895.

Preston, Ed. B., M. E. California Gold Mill Practices. California State Mining Bureau. San Francisco. 1895.

Poor, H. V. Directory of Railway Officials. Tenth Annual Number. H. V. & H. W. Poor, N. Y. 95. Cloth. $3.

Foster Engineering Co., Newark, N. J., U. S. A.=Catalogue, 16 pp., illustrating and describing "New Class W" pressure regulators, reducing valves and pump governors for regulating pressures of steam, water, gas, or air.

The Electric Storage Battery Co., Philadelphia, Pa., U. S. A.=Pamphlet, 52 pp., illustrating and describing the "Chloride Accumulator."

Flush Tank Co., Chicago, Ill., U. S. A.=(a) Catalogue of Sewer Siphons. (b) Pamphlet illustrating and describing siphon eduction range water closets for schools, factories, and public buildings.

P. F. Olds & Son, Lansing, Mich., U. S. A. =Catalogue. Illustrates and describes gas- and gasoline-engines.

Rue Manufacturing Co., Philadelphia, Pa., U. S. A.=Catalogue B. Illustrates and describes, with price lists, a line of "Little Giant," "Fixed Nozzle," and "Unique" injectors.

Knowles Steam Pump Works, New York, Boston, Chicago, U. S. A., and London, Eng. =Special Catalogue, illustrating and describing electric power pumps.

The Waterbury Farrel Foundry and Machine Co., Waterbury, Conn., U. S. A.=Catalogue, 318 pages, in book form, illustrating and describing an extensive line of machine tools, machinery, and appliances.

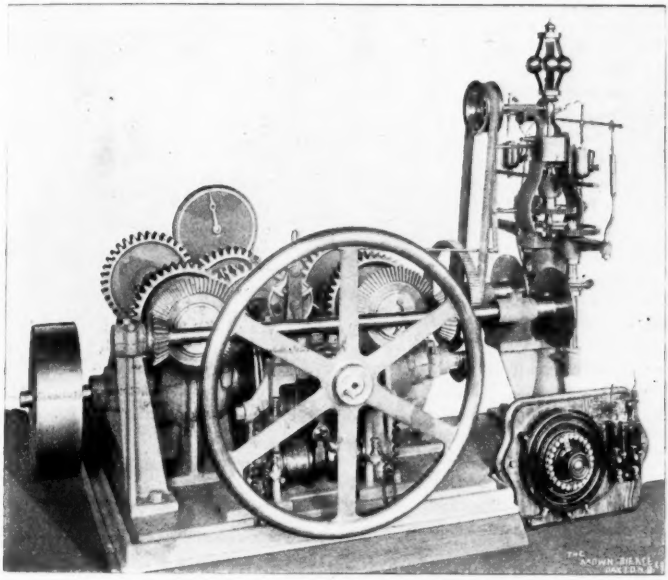
IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Giesler Electro Mechanical Water Wheel Governor.

THE Stilwell-Bierce & Smith-Vaile Co., of Dayton, Ohio, has taken the lead in developing the horizontal type of turbines and in adapting them to the requirements of electrical generators. For a long time no governing device for water wheels was adequate to meet the sudden and material changes in load, and to maintain uniform speed. Now a variation not exceeding one per cent. is desired. Ordinary governors are useless for close regulation. Fair results are obtained by the use of a hydraulic piston, but there are objections to this in actual practice, and it is expensive both to build and maintain. After much experiment the company named finally adopted the form shown in the accompanying cut, which it now exclusively controls. With this machine, the slightest variation in speed is instantly multiplied to any desired extent, to open or close the water wheel gate long before the ordinary balls, as used in other governors, would show any sign of moving. The governor can be arranged so as to fully open or close the water wheel gate in from three to fifteen seconds according to the requirements of the situation. The engineers of the company have been experimenting along this line for two years, sparing neither time or expense, and their efforts have resulted in perfecting a governor of such excellence as to entitle it to the same preëminence among water wheel govern-



GIESLER ELECTRO MECHANICAL WATER WHEEL GOVERNOR.

ors that the "Victor" turbine enjoys among water wheels,—a preëminence resting upon demonstrated results. The severe requirements of a water wheel governor are fully met with this governor, which is sold under a guarantee that it will perform all it is recommended to do. Only very small balls are used in this governor, because the balls are relieved of work; such, for instance, as lifting a valve against pressure, lifting a pawl or moving a slide, etc. The balls and their attachments are all finely balanced, and their movements are magnified so much that the slightest variation in centrifugal action will at once open or close the water wheel gate as required.

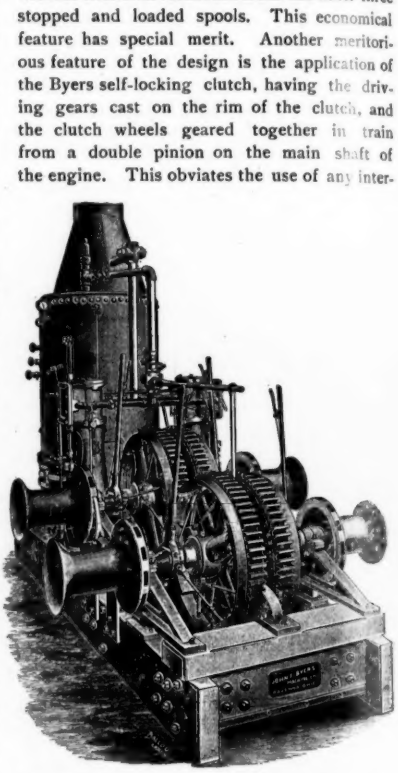
This company has taken the contract for the complete water power plant to be installed at the celebrated Lachine rapids in the St. Lawrence river. This power—owned by The Lachine Rapids Hydraulic & Land Co., Limited, of Montreal, Canada—is situated about five miles above Montreal, and is second only to Niagara Falls in importance. The initial development will amount to 10,000 horse power. The work of construction has already been begun, and the company expects to be prepared to furnish power before the close of this year.

Double Cylinder Bridge Erecting Engine.

THE cut shows a machine designed especially for the erection of bridges and structural iron work, and manufactured by The John F. Byers Machine Co., of Ravenna, Ohio.

The engine is of standard vertical, double-cylinder type, quick in starting, uniform in speed, safe in handling, and is fitted with four independent acting spools, operated with a special form of the Byers self-locking friction clutch. These clutches are easily and safely applied or released by conveniently placed levers, while the engine is in motion, without the least delay or jar on any part of the machine,—an advantage which those familiar with the working of crab or jaw clutches used for like purposes will readily appreciate.

The spools are of special design. Each spool is provided with a strong and easily worked ratchet and pawl, and can be securely stopped and made to hold any load the engine can hoist. The spools are keyed to the shafts and so mounted as to be absolutely independent in action (while the clutches are free), not only of each other, but of all the moving parts of the engine and its driving gears, hence any one spool, or any combination of spools, can be operated under a load, at any one time, the work performed being limited only by the hoisting capacity of the engine. Moreover, when any three spools are idle, either unloaded or stopped, and each holding any load that the machine can lift, the entire hoisting power of the engine can be applied to the remaining spool, and the maximum load hoisted without frictional resistance from the other three stopped and loaded spools. This economical feature has special merit. Another meritorious feature of the design is the application of the Byers self-locking clutch, having the driving gears cast on the rim of the clutch, and the clutch wheels geared together in train from a double pinion on the main shaft of the engine. This obviates the use of any intermediate gearing, and reduces to a minimum the number of working parts. As will be seen, the machine is entirely self-contained.



DOUBLE CYLINDER BRIDGE ERECTING ENGINE.

The engines are strongly and compactly built. Large steel shafts with ample bearings and extra heavy gear wheels are used, adapting the machine to the particular work to be performed.

The "Jenkins '96 Packing."

JENKINS BROTHERS, 71 John Street, New York, are, we believe, the originators of unvulcanized joint packing. For a considerable period

they have been experimenting with the object of still further advancing the art, and are now producing a packing that is claimed to fill all requirements, and which they are marketing under the name given in the title.

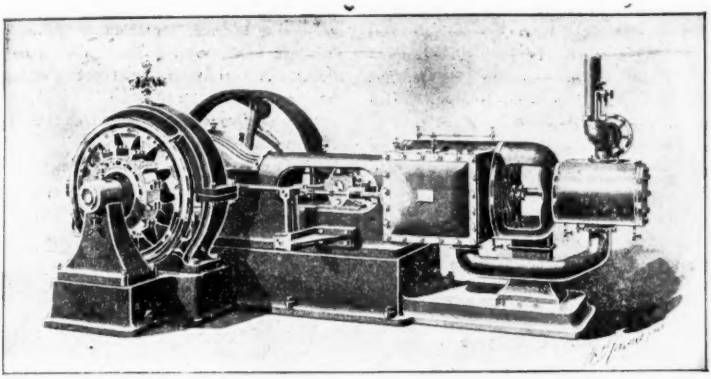
The old Jenkins packing was generally admitted to be of great excellence, but the recent improvements have added materially to its efficiency. It is claimed for the newer material, that it will not rot, burn, blow, or squeeze out under any conditions, that it will last as long as the metal itself, and that it can be used again and again. The manufacturers are willing to stake their reputation upon the exact truth of these claims.

The packing is equally adapted for hot or cold joints, and may be used for all pressures of steam, for superheated steam, oils, acids, etc.

brushes to the proper point as the load changes, more or less sparking occurs.

After careful study of the causes leading to these difficulties, and after a long series of experiments, Prof. Harris J. Ryan of Cornell University, assisted by Milton E. Thompson, E. E., has designed a direct current dynamo which is claimed to be well-nigh perfect, and to be a radical departure from well-trodden paths. The direct connected type is herewith illustrated.

The dynamo is of the multipolar type, having from 10 to 18 poles, according to size. The principal feature of the machine is a set of coils called "balancing coils," which are wound into a slotted cast steel pole ring. These coils are in series with the armature, and entirely neutralize all magnetic effects due to armature currents, and



REMARKABLE ADVANCE IN DIRECT CURRENT DYNAMO DESIGN.

A Remarkable Advance in Direct Current Dynamo Design.

BUILDERS of dynamo electric machinery have long sought to eliminate armature reaction, the one thing which has been a source of continual annoyance and expense to the owner by reason of sparking at the brushes, which is destructive to the commutator.

The actual results attained by the principal manufacturers may be seen by carefully watching the operation of their machines, and, if the load be a changeable one, the destructive spark will surely be in evidence. In the modern building with electric elevators, the load is constantly changing, and, as no engineer can be at all times in attendance at the dynamo to adjust the

give a field of exactly the requisite strength for sparkless commutation. The field coils proper require only one-fourth the energy usually consumed in ordinary design, and the armature carries from three to four times the depth of copper used in other machines. The brush holders—connected to brass rings of negative and positive polarity, insulated from and fastened to the field casting—project outward, and leave the entire outer end of the commutator free and accessible. The only loads employed on the whole machine are from the negative brush holder ring to the negative terminal, and another from the positive brush holder ring to the inner end of the balancing coils. The brush holders themselves are fixed, and hold the brushes in such a way that they require no adjustment, but have only to be slipped

into the holder. This results in entire freedom from sparking under any or all conditions of load.

The whole brush holder arrangement is adjustable around the commutator, and by loosening the clamp bolts the brushes may be shifted backward or forward, for adjusting the compounding of the machine. In this way the machines may be adjusted through a range of from 10 per cent. drop at full load to 10 per cent. rise, and this without any effect whatever on the commutation.

An unusually high efficiency under light loads. and the very great range of uniform efficiency are claimed as due to the very small fixed losses,—the result of the very small field energy consumed and the light core losses.

Another important feature of this dynamo is the great ease with which two or more machines may be worked in parallel. They may be thrown in parallel while differing widely in voltage produced, and each machine will take its due proportion of the load, notwithstanding the fact that they may be greatly over-compounded. Two or more of these machines will work perfectly in parallel, and divide the lightest load evenly or maintain perfect unison with the entire load thrown off.

The dynamo is built in sizes from 25 k. w. capacity to any size desired, both belted and direct connected. The manufacturers are J. H, McEwen Mfg. Co., 21 Dey street, New York.

The Cleveland Bicycle.

THE engravings of the extensive works of H. A. Lozier & Co., in Mr. Arnold's article this month, will doubtless elicit a desire on the part of many of our readers to know just what sort of a machine it is that has given rise to, and maintains, an industry of this magnitude and importance.

In the first place, while every refinement in machinery is to be found in these works, and although a carefully worked-out system of manufacture enables the most economical work to be done, the machines, which we illustrate, are claimed to be the most expensive to build on the market.

Such a statement can only mean that in material, workmanship, and finish they are superior to others.

Fig. 1 represents the "Cleveland" tandem, model No. 25. This machine has 28-inch wheels; 80-inch gear; small hubs; 1⅝ inch Cleveland detachable cross-thread tire (Schrader valve); wood rims; Burwell dust-proof bearings; 22½-inch front steering diamond frame; 1¼-inch tubing; 9-inch head; 5-inch tread; 65⅝-inch wheel base; 1⅜-inch flat front fork; double-fork crown; ⅞-inch tubular rear forks; ⅜-inch Cleveland hardened block and pin chain; detachable and interchangeable sprockets; Cleveland drop-forged, spring-tempered, detach-

FIG. 1.

able cranks, 6½-inch throw; new Cleveland dust-proof rat-trap pedals; Cleveland saddle; tubular L post; Cleveland reversible handle-bar; cork handles, with vulcanite tips; double butt-ended spokes, enameled to intersection; tool-case and tools; finish, black enamel and nickel. A variety of substitute specifications may be added to the above all of which are set forth in an elegant pamphlet which the company willl supply to inquirers.

Fig. 2 is the combination tandem, model No. 26. It differs from No. 25 in having 68-inch gear, 1½-inch Cleveland single-tube tire, 23-

FIG. 2.

inch diamond frame, steering from both handle-bars, 42½-inch wheel base, direct tubular post, and Cleveland 19-inch "rams-horn" style handle bar.

FIG. 3.

Fig. 3 represents the special "Ladies" wheel No. 23, whose points are wheels, 26 or 28 inches; small hubs; 1⅜-inch cross-thread detachable pneumatic tire (Schrader valve); large tubing (1¼-inch); wood rims; drop frame,

combination straight and loop ; flat forks ; double-fork crown ; Burwell dust-proof bearings ; 5-inch narrow tread ; detachable sprockets, front and rear ; ½-inch Cleveland hardened block and pin chain ; new Cleveland dust-proof rubber pedals ; Cleveland drop-forged, spring-tempered, detachable cranks, 6¼-inch throw ; 18-inch reversible raised or drop handle-bars ; improved Cleveland saddle, with hollow reversible posts ; double butt-ended spokes, enameled to intersection ; tool-case and tools, including repair outfit ; finish, black enamel and nickel ; Cleveland detachable, woven, linen and silk dress and chain guard. Specifications added to the above will supply a wheel suited to all tastes.

These wheels have acquired a world-wide reputation. In all their features they have been most carefully planned and studied, and each wheel is a masterpiece of mechanical construction, and of elegant design throughout.

Graphite Lubrication on Railroads.

AT the December meeting of the New York Railroad Club the subject of the cause of train detentions was discussed. Mr. C. M. Mendenhall had prepared a very interesting table showing that, if a positive cure can be found for hot boxes, hot crank pins, and hot eccentrics, then the chief causes of train detentions will be eliminated.

For the past year superintendents of motive power, master mechanics, and engineers have been making exhaustive tests that have demonstrated beyond any reasonable doubt that where engines have been equipped with Dixon's pure Flake Graphite, and the graphite properly used, there have been no delays due to hot driving boxes, crank pins, or eccentrics.

Complete proof of this statement can be obtained from the manufacturers, the Joseph Dixon Crucible Co., Jersey City, N. J., who will supply samples as well as full information.

The Beaudry Champion Power Hammer.

OF the simplest possible construction, possessing but few parts, this hammer is built upon such scientific principles that not only all the essentials of a superior tool are obtained, but also several important advantages peculiar to itself. It has no beam, no saddle, no rubber or spiral springs, or straps of any sort. It is direct-acting, completely under the control of the operator, and can be instantly adjusted so that the full stroke can be had on a piece four inches square as readily as on a piece one-half inch in thickness.

The power is obtained through a short shaft, 12 inches in bearing, having at one end a heavy slotted disk carrying an adjustable eccentric pin, to which is attached the rod, which can also be adjusted as shown for short or long stroke ; the rod passes through a spring box, which can also be instantly adjusted. The hammer will deliver equally powerful blows on widely varying thicknesses of metal, and no change is necessary except for very unusually heavy or special work.

The spring box receives the two spring arms provided with hardened steel rolls at their lower extremities, which run in a circular concave track and serve to lift the ram, which is entirely independent of the machine by any other connection, thus doing away with all jar or vibration and effectually preventing crystallization of any of the parts. The peculiar construction of this concave curved track, combined with the action of the spring arms and rolls, imparts an elasticity to the ram which is obtained in no other hammer through the medium of the various springs used, spiral, elliptic, or rubber. The ram is counterbalanced in the pulley to raise it to its highest position when stopped. The anvil sets through the frame (but independent of it) six inches below the floor line, on its own foundation. The working parts are all made of the best of steel suited for the purpose. The frame is built to secure the greatest amount of strength and solidity but occupies a small area of floor space.

The hammer can be run at a high speed, and will deliver a blow from one pound up to its full capacity, which, with the ready adjustability of the machine to receive large or small work, renders it the most economical running hammer ever built, it has been highly endorsed by several well-known firms. Twelve sizes are built, for every class of work, by Beaudry & Co., 35 Oliver street, Boston.

The Hunt Coupling for Transmission Rope.

THE gradual lengthening of a transmission rope increasing the sag through rapid wear from slipping on pulleys, until it becomes necessary either to resplice the rope or to use a take-up sheave with a very long range of motion, is obviated by the "Hunt" rope coupling herewith illustrated.

This device obviates the necessity for resplicing, etc., and will keep a rope at exactly the right tension for most effective service and long life, with little or no extra time or attention, and no expense after the first cost of the coupling. The device is made wholly of aluminum bronze having a tensile strength of 60,000 pounds to the square inch, and an elongation of 20 per cent. in eight inches. It has only two parts, a screw and a socket, which screw together when the rope is first put on the pulleys, and lock so securely that the coupling can be separated only by using a wrench of special design.

No. 95126

No. 95127

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An important and interesting feature is an internal swivel and ratchet;—see Fig. 3. The swivel permits the joint to yield to the curvatures of the pulleys while the ratchet holds the part from revolving on each other and untwisting therope. The coupling is smaller in diameter than the rope, and does not touch the grooves of the pulleys, even when the rope is worn.

The rope of the correct length for the drive when connected up is spliced into the coupling, and, as it wears longer, more "turns" are put into it by revolving one part of the coupling, the ratchet automatically holding all secure when the rope has the proper length and tension.

When several independent ropes are run side by side on a pulley, all can be kept at the same tension with the greatest exactness by putting a few more turns in the slack one when such a condition is noticed. In a multiple rope drive, any single rope can be taken off in a few minutes, and the work done by the remaining one, until it is convenient to put on a new rope, which can be done with equal dispatch, and with the tension adjusted to correspond exactly with the other ropes. The cost of a rope drive with this coupling spliced in and installed in position on the pulleys is usually less than that of ropes spliced on the spot by the purchaser in the ordinary way, and it is also less than a rope drive with a tension pulley, which, in addition to its cost, frequently requires space that is useful for other purposes. Transmission ropes require to be spliced two or three times during their life, while the couplings, having no wear, are permanent, entailing no expense after being once installed. Thus this method is much the cheaper as well as the better one.

The convenience of installation, facility of adjustment of tension, perfect control of the sag, and increased life of the rope from a more equal tension justify an expenditure of many times the cost of the couplings.

The C. W. Hunt Company, 45 Broadway, New York city, are the exclusive licensees in the United States for the patent on this coupling, and supply transmission rope of the well-known "Stevedore" brand and of the usual sizes with the couplings spliced in position.

Steam Launches for Mexico.

THE first of several steam launches, of special design for Southern Mexico, has recently been shipped by the Marine Iron Works, Clybourn and Southport Aves., Chicago, the destination being 3200 miles from that city. Shipments of this character are safely made by rail for the small and medium-sized launches, but for larger work the same company build only the "complete outfits" of marine machinery and equipment for the native boat builders.

A Successful Woman Inventor.

MRS. LOTTIE COX, of Blue Springs, Nebraska, has just been awarded a prize of $150 for the best and simplest invention submitted to the patent firm of John Wedderburn & Co., of Washington, D. C.

Mrs. Cox is the first woman who has been successful in these monthly competitions which have now been in progress for the past year. The invention is a work table supplied with numerous conveniences much appreciated by women.

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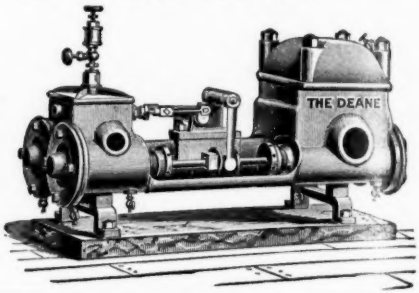

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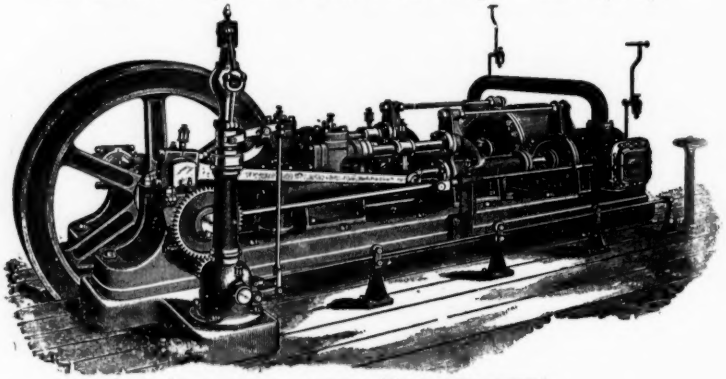

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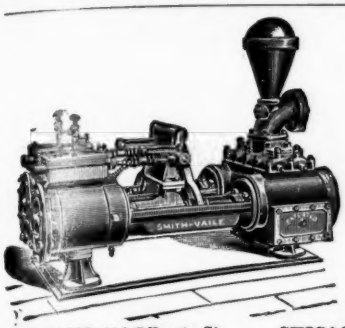

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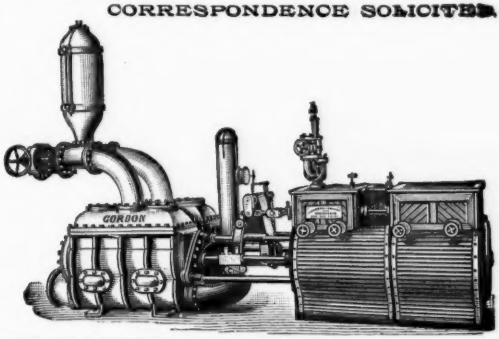

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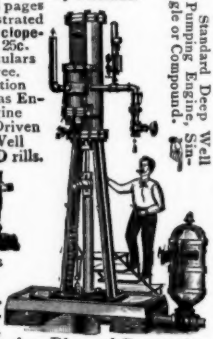

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